QUANTA CHEMISTRY

An Institute of Chemical Sciences

THERMODYNAMICS

(BASIC QUESTIONS)

1. The temperature of the system decreases in an

   (a) Adiabatic compression (b) Isothermal compression

   (c) Isothermal expansion (d) Adiabatic expansion

2. If a refrigerators door is opened. then we get

   (a) Room heated (b) Room cooled

   (c) More amount of heat is passed out (d) No effect on room

3. The process, in which no heat enters or leaves the system, is termed as

   (a) Isochoric (b) Isobaric

   (c) Isothermal (d) Adiabatic

4. Warming ammonium chloride with sodium hydroxide in a test tube is an example of :

   (a) Closed system (b) Isolated system

   (c) Open system (d) None of these

5. Out of boiling point (I), entropy (II). pII (II) and e.m.f. of a cell (IV), intensive properties are

   (a) I, II (b) I, II, III

   (c) I, III, IV (d) AII the above

6. A thermodynamic state function is

   (a) one which obeys all the laws of thermodynamics

   (b) a quantity which is used m measuring thermal changes

   (c) one which is used in thermo chemistry

   (d) a quantity whose value depends only on the state of the system.

7. In thermodynamics, a process is called reversible when

   (a) surroundings and system change into each other

   (b) there is no boundary between system and surroundings

(c) the surroundings are always in equilibrium with the system

(d) the system changes to the surroundings spontaneously

8. Enthalpy is an property.

(a) Extensive (b) Exclusive

(c) Intensive (d) Inclusive

9. Hess law of heat summation includes

(a) Initial reactants only (b) Initial reactants and final products

(c) Final products only (d) Intermediates only

10. Which is the best definition of “heat of neutralization”

(a) The heat set free when one gram molecule of a base is neutralized by one gram molecule of an acid in dilute solution at a stated temperature

(b) The heat absorbed when one gram molecule of an acid is neutralized by one gram molecule of a base in dilute solution at a stated temperature

(c) The heat set tree or absorbed when one gram atom of an acid is neutralized by one gram atom of a base at a stated temperature

(d) the heat set free when one gram equivalent of an acid is neutralized by one gram equivalent of a base in dilute solution at a stated temperature

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THERMODYNAMICS

(BASIC QUESTIONS)

1. (d)
2. (c)
3. (d)
4. (c)
5. (c)
6. (d)
7. (c)
8. (b)
9. (a)
10. (d)

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DPP- 01 THERMODYNAMICS

1. The value of 3000 Joule is equal to

(a) > 30 Litre-atm (b) < 30 Litre-atm

(c) = 30 Litre-atm (d) None of these

2. The value of 1 Joule = M^n litre-bar in n = –1 then the value of M is

(a) 10 (b) 100

(c) 10^{-2} (d) 10^4

3. The correct thermodynamic relations among the following is

(a) $\left(\frac{\partial U}{\partial V}\right)_S = -P$ (b) $\left(\frac{\partial H}{\partial V}\right)_S = -P$

(c) $\left(\frac{\partial G}{\partial V}\right)_S = -P$ (d) $\left(\frac{\partial A}{\partial V}\right)_S = -S$

4. According to one of the Maxwell reactions, $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$. Hence for 1 mole of an ideal gas, $\left(\frac{\partial S}{\partial V}\right)_T$ is equal to

(a) P/T (b) T/P

(c) PT (d) P/V

5. From Maxewall thermodynamics relation. The value of p may be obtained in terms of first partial derivatives of thermodynamic potential

(a) G, U (b) G, A

(c) A, U (d) H, U

6. The value of $\left(\frac{\partial G}{\partial T}\right)_P$ is equal to

(a) $\left(\frac{\partial A}{\partial T}\right)_V$ (b) $\left(\frac{\partial A}{\partial V}\right)_T$

(c) $\left(\frac{\partial U}{\partial T}\right)_V$ (d) $\left(\frac{\partial A}{\partial T}\right)_P$

7. The value of $\left(\frac{\partial S}{\partial P}\right)_T$ is equal to

(a) $\left(\frac{\partial V}{\partial T}\right)_P$ (b) $-\left(\frac{\partial V}{\partial P}\right)_T$

(c) $-\left(\frac{\partial V}{\partial T}\right)_P$ (d) $\left(\frac{\partial V}{\partial P}\right)_T$

8. The change in Enthalpy with respect to change in pressure at constant entropy is equal to

(a) Temperature (b) Volume

(c) Pressure (d) Entropy

9. The change in internal energy with respect to change in entropy at constant volume is

(a) Pressure (b) Volume

(c) Temperature (d) Entropy

10. The change in value of thermodynamic potential G with respect to P at constant temperature is

(a) V (b) –S

(c) P (d) –V

11. For an isolated thermodynamical system- p, V, T, U, S and A represent the pressure, volume, temperature, internal energy, entropy and free energy respectively. Then, the following relation is true

(a) $\left(\frac{\partial A}{\partial T}\right)_V = -S$ (b) $\left(\frac{\partial A}{\partial T}\right)_p = -S$

(c) $\left(\frac{\partial U}{\partial S}\right)_p = T$ (d) $\left(\frac{\partial U}{\partial V}\right)_T = -p$

12. The criterion for spontaneous change in terms of the state functions is

(a) $dU_{S,V} \geq 0$ (b) $dA_{T,V} \geq 0$

(c) $dS_{U,V} \geq 0$ (d) $dG_{P,V} \leq 0$

13. Choose the correct criterian of spontaneity in terms of properties of system alone

(a) $dS_{U,V} > 0$ (b) $dS_{T,P} > 0$

(c) $dS_{H,P} < 0$ (d) $dG_{T,V} < 0$

14. The criterion of spontaneous change in terms of state function is

(a) $dU_{S,V} \geq 0$ (b) $dA_{T,V} \geq 0$

(c) $dS_{U,V} \geq 0$ (d) $dG_{T,V} \leq 0$

15. The Maxwell relation that may be obtained by dG = SdT – VdP is

(a) $\left(\frac{\partial V}{\partial T}\right)_P = \left(\frac{\partial S}{\partial P}\right)_T$

(b) $\left(\frac{\partial V}{\partial T}\right)_P = -\left(\frac{\partial S}{\partial P}\right)_T$

(c) $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$

(d) None

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ANSWER KEY

1. (b)	6. (a)	11. (a)
2. (b)	7. (c)	12. (d)
3.(a)	8. (b)	13. (a)
4. (a)	9. (c)	14. (c)
5. (c)	10. (a)	15. (b)

HINTS & SOLUTIONS

1. $R = 0.0821\ L\ atm\ k^{-1}\ mol^{-1}$

$R = 8.314\ J\ k^{-1}\ mol^{-1}$

For conversion of Joule into litre atm,

Multiply by the value of (R) with unit litre-atm of divide by the value of (R) with unit Joule.

$$3000\ J \times \frac{0.0821\ L\ atm\ k^{-1}\ mol^{-1}}{8.314\ J\ k^{-1} mol^{-1}}$$

≈ 29.62 L-atm

i.e., 3000 Joule < 30 litre-atm

Correct option is (B)

2. 1 Joule = M^n litre bar

n= –1 (given)

1 Joule = M^{-1} litre bar

$$1J \times \frac{0.083\ L\ bar\ k^{-1} mol^{-1}}{8.314\ k^{-1} mol^{-1} J} = M^{-1}\ \text{Litre bar}$$

9.98×10^{-3} L bar = M^{-1} L bar

10^{-2} L bar = M^{-1} L bar

M = 100

Correct option is (B)

3. From Maxwell magic square, we know

(a) dV = TdS – PdV

$$\left(\frac{\partial U}{\partial V}\right)_S = -P$$

(d) dA = – PdV – SdT

$\left(\frac{dA}{dV}\right)_T = -S$ this option will only be true when the temperature is kept constant rather than entropy.

Correct option is (a)

4. $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$

Ideal gas, PV = RT {n = 1 mole}

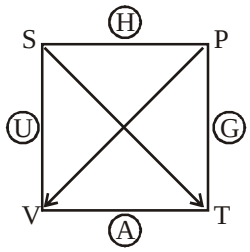
$$\left(\frac{\partial P}{\partial T}\right)_V = \frac{R}{V}$$

Also, $R = \frac{PV}{T}$

Then, $\left(\frac{\partial P}{\partial T}\right)_V = \frac{PV}{T\times V} = \frac{P}{T}$

$$\left(\frac{\partial P}{\partial T}\right)_V = \frac{P}{T}$$

Correct option is (a)

5. 

$\partial U = TdS - PdV$

$$\left(\frac{\partial U}{\partial V}\right)_S = -P$$

$$\partial A = -PdV - SdT$$

$$\left(\frac{\partial A}{\partial V}\right)_T = -P$$

$\therefore$ P can be obtained in terms of (A, U)

Correct option is (C)

6. We know variables in terms of potential,

$$S = -\left(\frac{\partial A}{\partial T}\right)_V \text{ and } -\left(\frac{\partial G}{\partial T}\right)_P$$

$$\therefore \quad -\left(\frac{\partial A}{\partial T}\right)_V = -\left(\frac{\partial G}{\partial T}\right)_P$$

$$\left(\frac{\partial A}{\partial T}\right)_V = \left(\frac{\partial G}{\partial T}\right)_P$$

Correct option is (A)

7. From the Maxwell relation,

$$\left(\frac{\partial S}{\partial P}\right)_T = -\left(\frac{\partial V}{\partial T}\right)_P$$

Correct option is (C)

8. $dH = TdS + VdP$

$$\left(\frac{dH}{dP}\right)_S = V\,(\text{Volume})$$

Correct option is (B)

9. $dU = TdS - PdV$

$$\left(\frac{dU}{dS}\right)_V = T\,(\text{Temperature})$$

Correct option is (C)

10. $dG = -SdT + VdP$

$$\left(\frac{dG}{dP}\right)_T = V$$

Correct option is (A)

11. $dA = -PdV - SdT$

$\left(\frac{\partial A}{\partial T}\right)_V = -S$ True

$\left(\frac{\partial A}{\partial T}\right)_P = -S$ False

$dU = TdS - PdV$

$\left(\frac{dU}{dS}\right)_P = T$ False

$\left(\frac{\partial U}{\partial V}\right)_T = -P$ False

Correct option is (A)

12. $(dS)_{U,V} \geq 0$

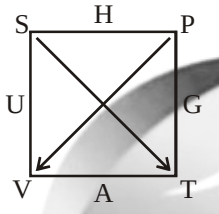
$(dS)_{H,P} \geq 0$

$(dS)_{V,U} > 0$

$(dU)_{P,T} \leq 0$

$(dU)_{U,V} \leq 0$

Correct option is (C)

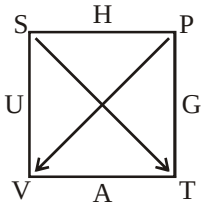


13. $dS_{U,V} > 0$

Correct option is (A)

14. $DS_{U,V} \geq 0$

Correct option is (C)

15. 

$-\left(\frac{\partial V}{\partial T}\right)_P = \left(\frac{\partial S}{\partial P}\right)_T$

Correct option is (B)

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DPP- 2 THERMODYNAMICS

1. The thermodynamic potential which must be negative for spontaneous process at constant temperature and at constant pressure

   (a) G (b) H

   (c) A (d) U

2. A process is carried out at constant volume and at constant entropy. It will be spontaneous if :

   (a) $\Delta G < 0$ (b) $\Delta U < 0$

   (c) $\Delta A < 0$ (d) $\Delta H < 0$

3. Find the heat of formation of ethyl alcohol.

   $C(s) + O_2(g) = CO_2(g);$ $\Delta H = -94$ k cal

   $H_2(g) + \frac{1}{2} O_2(g) = H_2O(g);$ $\Delta H = -68$ k cal

   $C_2H_5OH(l) + 3O_2(g) = 2CO_2(g) + 3H_2O(l);$ $\Delta H = -327$ k cal

4. Which has maximum internal energy at 298 K?

   (a) helium gas (b) oxygen gas

   (c) ozone gas (d) equal

5. The degree of freedom that is mostly affected by temperature is

   (a) Vibrational DOF (b) Rotational DOF

   (c) Translational DOF (d) Electronic DOF

6. The value of heat capacity of a colourless gas is found to be 25 J/K-mole than the gas would be

   (a) O_2 (b) N_2

   (c) CO_2 (d) SO_2

7. The heat capacity at constant volume C_V of C_2N_2 and $AsCl_3$ in gaseous state are 78.982 JK^{-1} mol^{-1} and 74.83 JK^{-1} mol^{-1}. (assume all degree of freedom contribute) What are the structures of the molecule?

   (a) linear, linear (b) nonlinear, linear

   (c) linear, nonlinear (d) nonlinear, nonlinear

8. An ideal gas expands by following an equation PV^a = constant. In which case does one expect heating?

(a) $3 > a > 2$ (b) $2 > a > 1$

(c) $0 < a < 1$ (d) $-1 < a < 0$

9. ΔH and ΔU for the reaction,

$Fe_2O_3(s) + 3H_2(g) \rightarrow 2Fe(s) + H_2O\ (l)$ at constant temperature are related as

(a) $\Delta H = \Delta U$ (b) $\Delta H = \Delta U + RT$

(c) $\Delta H = \Delta U + 3RT$ (d) $\Delta H = \Delta U - 3RT$

10. Incorrect statement regarding heat capacity are

(a) heat capacity are path function and inexact differential

(b) heat capacity of solid is higher than heat capacity of liquid

(c) the ratio of heat capacity is known as atomicity of the gas and depends on number of atom

(d) heat capacity may be infinite

11. The incorrect relation between heat capacity at constant pressure and constant volume are

(a) $C_P - C_V = T\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial V}{\partial T}\right)_P$

(b) $C_P - C_V = T\left(\frac{\partial P}{\partial T}\right)_V^2 \left(\frac{\partial V}{\partial P}\right)_T$

(c) $C_P - C_V = R$(for 1 mole of ideal gas)

(d) $C_P - C_V = R(1 + 2a/RTV)$

12. For an ideal gas $\left(\frac{\partial H}{\partial T}\right)_P$ is equal to

(a) C_P (b) C_V

(c) 0 (d) 1

13. When we plot a graph between U vs T at constant volume the slope in the plot is

(a) C_P (b) C_V

(c) 1 (d) can not determine

14. Consider the statements

(i) Heat is either internal energy or enthalpy in transit depending on the experimental condition

(ii) When heat is absorbed by the system a change of temperature may or may not change

(iii) Heat capacity may be positive negative or infinite.

(iv) $\left(\frac{\partial C_V}{\partial V}\right)_T$ for ideal and van der wall is 0

The correct above are

(a) (ii), (iii) (b) (i), (ii)

(c) (i), (iii) and (iv) (d) All are correct

15. Incorrect statement from the given statement is

(a) In adiabatic free expansion, internal energy remains constant

(b) The ratio of C_P and C_V for ideal gas is dependent on temperature only

(c) The difference between heat capacity for ideal gas is not function of temperature

(d) In case of van der wall gas C_P is independent of pressure and dependent on temperature

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ANSWER KEY

1. (a)	6. (d)	11. (b)
2. (b)	7. (c)	12. (a)
3. (c)	8. (d)	13. (b)
4. (c)	9. (d)	14. (b)
5. (a)	10. (b)	15. (d)

HINTS & SOLUTIONS

1. At cost T, P
   G is –ve
   Correct option is (A)
2. S, V constant
   $dV < 0$
3. Adiabatic process is enthalpic when the process is reversible & is at constant pressure.
   $q = 0$
   Correct option is (c)
4. $\Delta U = C_V dT$
   C_v for He (monoatomic) = 1.5 R
   C_v for Oxygen (diatomic) = 3.5 R
   C_v for ozone (Triatomic, non linear) = 6R
   ∵ Maximum C_v is for ozone
   ∴ maximum internal energy is also for ozone.

Correct option is (c)

5. Vibrational DOF is mostly affected by temperature.

Correct option is (A)

6. SO_2 = Non linear molecule

Total DOF = $\frac{3}{2}R + \frac{3}{2}R$ (Excluding vibrational DOF)

$= 3R$

$= 3 \times 8.314$

$= 24.9$

≈ 25

Correct option is (d)

7. Total DOF for non linear molecule, = 9 R

$= 9 \times 8.314$

$C_V = 74.826$

Total DOF for linear molecule = 9.5 R

$= 9.5 \times 8.314$

$C_V = 78.983$

C_2N_2 = linear

As Cl_3 = Non linear

Correct option is (C)

8. PV^a = constant

a = force of attraction

$-1 < a < 0$

Correct option is (d)

9. $Fe_2O_3(s) + 3H_2(g) \rightarrow 2Fe(s) + H_2O(\ell)$

We know, $\Delta H = \Delta U + \Delta n_g RT$ ... (1)

$\Delta n_g =$ (Stioch. of product in gaseous phase) – (Stioch. of reactant in gaseous phase)

$\Delta n_g = 0 - 3 = -3$

And using equation (1)

$\Delta H = \Delta U - 3RT$

Correct option is (D)

10. Heat capacity of solid is never higher than heat capacity of liquid.

At low temperature $C_{liq.} > C_{gas} > C_{solid}$

At high temperature $C_{gas} > C_{liq.} > C_{solid}$

Correct option is (B)

11. Correct heat capacity relations,

$$C_P - C_V = -T\left(\frac{\partial P}{\partial T}\right)_V^2\left(\frac{\partial V}{\partial P}\right)_T$$

$$C_P - C_V = -T\left(\frac{\partial V}{\partial T}\right)_P^2\left(\frac{\partial P}{\partial V}\right)_T$$

$$C_P - C_V = +T\left(\frac{\partial P}{\partial T}\right)_V\left(\frac{\partial V}{\partial T}\right)_P$$

Correct option is (B)

12. At constant pressure,

$$\frac{q_P}{\Delta T} = \frac{\Delta H}{\Delta T} = C_P$$

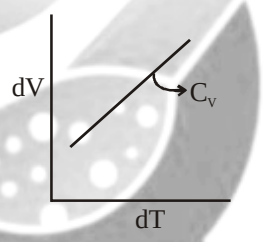
$$\left(\frac{\partial H}{\partial T}\right)_P = C_P$$

Correct option is (A)

13. $DU = TdS - PdV$

Diff. w.r.t. T at constant volume,

$$\left(\frac{\partial U}{\partial T}\right)_V = T\left(\frac{\partial S}{\partial T}\right)_V = C_V$$



Slope = C_V

Correct option is (B)

14. When the heat is absorbed by the system a change in temperature depends on the process whether it is isothermal or adiabatic. In isothermal process, the temperature is kept constant (dT = 0) Whereas in adiabatic it changes.

Heat is either internal energy or enthalpy in transit it depends on the condition whether the experiment is performed at constant volume or constant pressure.

Correct option is (b).

15. The difference in heat capacity is not always the function of temperature.

It can be the function of pressure as well as volume.

Correct option is (c)

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DPP- 3 THERMODYNAMICS

1. If a gas obey the van der wall equation of state the ratio of $(C_P - C_V)_{Ideal}$ and $(C_P - C_V)_{van\ der\ wall}$ is

   (a) $\left\{1+\left(\frac{2a}{RTV}\right)\right\}$ (b) $\left\{1-\left(\frac{2a}{RTV}\right)\right\}$

   (c) 0 (d) 1

2. The temperature of 100 gm of water is raised from 50°C to 100°C at constant pressure the change in enthalpy is

   (a) 20.91 KJ (b) 3.76 KJ

   (c) 104.54 KJ (d) 0

3. The heat capacity of 10 mole of an ideal gas at certain temperature is 300 JK^{-1} at constant pressure. The heat capacity of the same gas at same temperature and constant volume is

   (a) 383 JK^{-1} (b) 217 JK^{-1}

   (c) 134 JK^{-1} (d) 466 JK^{-1}

4. For two moles of an ideal gas difference between heat capacity at constant pressure and constant volume is

   (a) 0 (b) R

   (c) 2R (d) 3R

5. The inversion temperature of a gas is 193 K then gas show cooling if experiment is carried at

   (a) 80°C (b) 100°C

   (c) 273 K (d) 125 K

6. Which of the following feature is not correct about Joule Thomson experiment

   (a) The change in pressure is negative throughout experiment

   (b) The inversion temperature of H_2 and He is very low so it shows heating at ordinary temperature

(c) The process is adiabatic, isoenthalpic and also known as throttling process

(d) If attractive part dominate over repulsive term than gas does not liquefy.

7. For air at 300 K and 25 atm, μ_{JT} is 0.173 K atm^{-1}. If a Joule-Thomson expansion is carried out from a pressure of 50.00 atm at a pressure of 1.00 atm, the final temperature if (if the initial temperature is 300 K).

(a) 292 K (b) 308 K

(c) 284 K (d) None

8. The relation between critical temp (Tc) inversion temp (Ti) and Boyle temp (T_B) is

(a) $Tc > Ti > T_B$ (b) $Ti > T_B > Tc$

(c) $Ti > Tc > T_B$ (d) None of these

9. Heat of vaporization is zero at

(a) Boyle temp (b) Critical temp

(c) Boiling point (d) Never be zero

10. What is the inversion temperature for CO_2 gas. Given a = 3.64 dm^6 bar mol^{-2} and b = 0.04267 dm^3 mol^{-1}.

(a) 1026 K (b) 2052 K

(c) 4104 K (d) 2357 K

11. According to the cyclic rule, $\left(\frac{\partial P}{\partial V}\right)_T\left(\frac{\partial V}{\partial T}\right)_P\left(\frac{\partial T}{\partial P}\right)_V$ is equal to

(a) 0 (b) positive

(c) negative (d) infinity.

12. Which of the following is not an exact differential?

(a) dQ (Q = heat absorbed) (b) dU (U = internal energy)

(c) dS (S = entropy) (d) dG (G = free energy)

13. Incorrect statement regarding state function are

(a) these are exact differentials

(b) these follows Euler theorem

(c) The cyclic integral of these function is zero

(d) the summation of two inexact differential never be equal to exact differential

14. For one mole of an ideal gas $\left(\frac{\partial P}{\partial T}\right)_V\left(\frac{\partial V}{\partial T}\right)_P\left(\frac{\partial V}{\partial P}\right)_T =$

(a) –1 (b) $-\frac{R^2}{P^2}$

(c) +1 (d) $\frac{R^2}{P^2}$

15. For an ideal gas

(a) $\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial T}{\partial V}\right)_P \left(\frac{\partial V}{\partial P}\right)_T = 0$ (b) $\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial T}{\partial V}\right)_P \left(\frac{\partial V}{\partial P}\right)_T = -1$

(c) $\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial T}{\partial V}\right)_P \left(\frac{\partial V}{\partial P}\right)_T = +1$ (d) $\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial T}{\partial V}\right)_P \left(\frac{\partial V}{\partial P}\right)_T = +2$

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ANSWER KEY

1. (b)
2. (a)
3. (b)
4. (c)
5. (d)
6. (d)
7. (a)
8. (b)
9. (b)
10. (b)
11. (c)
12. (a)
13. (d)
14. (b)
15. (b)

HINTS & SOLUTIONS

1. (b)

Sol. $(C_P - C_V)_{ideal} = R$

$$(C_P - C_V)_{vander} = R\left(1+\frac{2a}{RTV}\right)$$

$$\frac{(C_P - C_V)_{ideal}}{(C_P - C_V)_{vanderwal}} = \frac{1}{\left(1+\frac{2a}{RTV}\right)}$$

2. (a)

Sol. 100 gm water

$T_1 = 50^oC$; $T_2 = 100^oC$ at constant pressure

$$n = \frac{100}{18} = 5.55$$

C_p = 7R (Including vibrational DOF)

$\Delta H = nC_p dT$

$\Delta H = 5.5 \times 7 \times 8.314(323)$

$\Delta H = 104.5 kJ$

Correct option is (c)

3. (b)

Sol. $C_p = 300\ J\,k^{-1}$ [Heat capacity at constant pressure]

We know,

$C_p - C_V = nR$ [n = 10 mole]

$C_p - C_V = 10\ R$

$C_V = C_p - 10\ R$

$C_V = 300 - 10(8.314)$

$C_V = 217\ J\,k^{-1}$

Correct option is (B)

4. (c)

Sol. $C_p - C_V = nR$

n = 2 given

$C_p - C_V = 2R$

Correct option is (C)

5. (d)

Sol. $T_i = \frac{2a}{Rb} = 193 k$

Cooling will occur when the temperature is below the inversion temperature and heating will be the case when temperatue is above the T_i.

$\therefore$ (d) 125 k as it is the only temperature below 193 k.

6. (d)

Sol. If repulsive part dominates over attractive part then the gas does not liquify

Correct option is (d)

7. (a)

Sol. $\left(\frac{\partial T}{\partial P}\right)_H = \mu_{JT}$ P_1 = 50 atm $\mu_{JT} = 0.173\ k\ atm^{-1}$

$\left(\frac{T_2 - T_1}{P_2 - P_1}\right) = \mu_{JT}$ P_2 = 1 atm

$\left(\frac{T_2 - 300}{1 - 50}\right) = 0.173 \quad T_1 = 300\ k$

$T_2 - 300 = -0.173\ (49)$ dP = always negative because of expansion

$T_2 = 298\ k$

Correct option is (A)

8. (b)

Sol. $T_i = \frac{2a}{Rb} \quad T_B = \frac{a}{Rb} \quad T_C = \frac{8a}{27Rb}$

$T_i > T_B > T_C$

Correct option is (B)

9. (b)

Sol. Critical temperature is the temperature which states that heat of vaporisation diminishes with increasing temperature & it vanishes completely at a point & that point is called critical temperature.

$\therefore \quad \Delta H_{vap} = 0$ at initial temperature.

Correct option is (b)

10. (b)

Sol. $T_i = \frac{2a}{Rb}$

$T_i = \frac{2 \times 3.64\ dm^6\ bar\ mol^{-2}}{0.04267\ dm^3\ mol^{-1} 0.0821 dm^3\ bar\ k^{-1}\ mol^{-1}}$

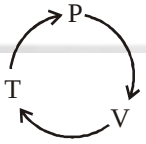
$T_i = 2052\ k$

Correct option is (B)

11. (c)

Sol. Are to cyclic rule,

$\left(\frac{\partial P}{\partial V}\right)_T \left(\frac{\partial V}{\partial T}\right)_P \left(\frac{\partial T}{\partial P}\right)_V = -1$



(C) Negative

12. (a)

Sol. For every state function, there exists an exact differential but for path functions, there is no exact differential.

Path function :- Q

State function :- U, G, S

Correct option is (a)

13. (d)

Sol. Summation of two inexact differentialnever be equal to exact differential.

14. (b)

Sol. Ideal gas, PV = RT {n = 1 mole}

$$\left(\frac{\partial P}{\partial T}\right)_V = \frac{R}{V} \quad \text{... (1)}$$

$$\left(\frac{\partial V}{\partial T}\right)_P = \frac{R}{P} \quad \text{... (2)}$$

$$\left(\frac{\partial V}{\partial P}\right)_T = -\frac{RT}{P^2} \quad \text{... (3)}$$

$$\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial V}{\partial T}\right)_P \left(\frac{\partial V}{\partial P}\right)_T$$

$$\left(\frac{R}{V}\right)\left(\frac{R}{P}\right)\left(-\frac{RT}{P^2}\right)$$

$$\left(\frac{R}{V}\right)\left(\frac{R}{P}\right)\left(-\frac{PV}{P^2}\right)$$

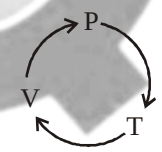
$$\frac{-R^2}{P^2}$$

Correct option is (B)

15. (b)

Sol. Are to cyclic rule

$$\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial T}{\partial V}\right)_P \left(\frac{\partial v}{\partial P}\right)_T = -1$$



Correct option is (B)

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DPP- 4 THERMODYNAMICS

1. Work done in the free expansion of an ideal gas is zero because
   (a) The intermolecular forces are zero
   (b) There is no friction
   (c) External pressure acting on the system is zero
   (d) Perfect vaccum cannot be created

2. For an ideal gas μ_{JT} is
   (a) positive (b) negative
   (c) zero (d) infinity

3. The value of isothermal compressibility factor β for n mole of an ideal gas
   (a) $\frac{1}{P}$ (b) $\frac{n}{P}$
   (c) $\frac{1}{P^2}$ (d) $\frac{-1}{P^2}$

4. The entropy change in terms of α, β and ΔV is
   (a) $\Delta S = \frac{\alpha \Delta V}{\beta}$ (b) $\Delta S = \frac{\alpha\beta}{\Delta V}$
   (c) $\Delta S = \frac{1}{\alpha\beta\Delta V}$ (d) can not determine

5. The relation between α, β, γ and P is
   (a) $\alpha\beta = \gamma P$ (b) $\alpha\gamma = \beta P$
   (c) $\alpha\beta\gamma = P$ (d) $\alpha = \beta\gamma P$

6. The value of $\frac{\alpha}{\beta}$ for $P(V - nb) = nRT$ is
   (a) $\frac{R}{V - nb}$ (b) $\frac{nR}{V - b}$

(c) $\frac{nR}{V - nb}$ (d) $\frac{nR}{V}$

7. The value of isothermal compressibility factor at critical point is

(a) zero (b) infinite

(c) 1 (d) any real number

8. Among the quantities q_{rev}, w, q_{rev}/T and $q_{rev} - w$ the state function are

(a) q_{rev}/T, $q_{rev} - w$ (b) q_{rev}, $q_{rev} - w$

(c) q_{rev}, q_{rev}/T (d) q_{rev}, T, w

9. Consider the statements

(i) q = 0 for every cyclic process

(ii) P – V work is usually negligible in case of solid and liquid

(iii) A thermodynamic process is specified by specifying the initial and final state of the system

(iv) Change in temperature is equal to zero for every adiabatic process

The true statements above are

(a) (ii), (iii) (b) (i), (ii) and (iii)

(c) (ii) only (d) (iii) only

10. An ideal gas, $C_V = (5/2)R$, is expanded adiabatically against a constant pressure of 1 atm until it doubles in volume. If the initial temperature is 25°C, and the initial pressure is 5 atm, the value of T_2 is

(a) 262 K (b) 274 K

(c) 238 K (d) 286 K

11. Consider 2 mole of an ideal diatomic gas at 300 K and 0.507 MPa to be expanded adiabatically to a final pressure of 0.203 MPa against a constant pressure of 0.101 MPa. The final temperature is (Given $C_V = 2.5$ R)

(a) 220 K (b) 250 K

(c) 150 K (d) 270 K

12. A sample of Argon Gas at 1 atm and 27°C expands reversibly and adiabatically from 1.25 litre to 2.50 litre. The change in enthalpy approximately is

(a) 11.5 Joule (b) 272 Joule

(c) 115 Joule (d) 0

13. One mole of monoatomic ideal gas expands adiabatically at initial temperature T against a constant external pressure of 1 atm from 1 L to 3 L. The final temperature of the gas is

(a) T (b) $T/3^{2.5\,R}$

(c) $T - 2/1.5 \times 0.082$ (d) $T + 2/1.5 \times 0.082$

14. In two separate experiment involving adiabatic reversible expansion taking monoatomic and diatomic gas in two different case if in each case initial temp and initial volume is same and final

volume is same the relation between final temperature would be

(a) $T_m = T_D$ (b) $T_m > T_D$

(c) $T_m < T_D$ (d) cant say

15. One mole of an ideal gas (Cp = 29.234 J/K mole) is expanded reversibly and adiabatically from 1 dm^3 to 10 dm^3. If the initial temperature is 750 K. The final temperature will be

(a) 1000 K (b) 750 K

(c) 300 K (d) 100 K

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ANSWER KEY

1.(c)	6.(c)	11.(d)
2.(c)	7.(b)	12.(a)
3.(a)	8.(a)	13.(c)
4.(a)	9.(a)	14.(c)
5.(d)	10.(b)	15.(c)

HINTS & SOLUTIONS

1. (c)

Sol. In case of free expansion,

$W = 0$

$P_{ext} = 0$ i.e., external pressure = 0.

Correct option is (C)

2. (c)

Sol. For ideal gas,

U = function of temperature only

In Joule Thomson :- Conditions :- adiabatic and free expansion process

Free expansion, $P_{ext} = 0$ $w = 0$ $\Delta U = 0$

$\Delta U = w$

$C_U (T_2 - T_1) = 0$

$\Delta T = 0$ i.e., dT = 0

$$\mu_{JT} = \left(\frac{\partial T}{\partial P}\right)_H = 0$$

Correct option is (C)

3. (a)

Sol. $\beta = -\frac{1}{V}\left(\frac{\partial V}{\partial P}\right)_T$

Ideal gas, PV = nRT

$$V = \frac{nRT}{P}$$

$$\left(\frac{\partial V}{\partial P}\right)_T = -\frac{nRT}{P_2}$$

$$\beta = -\frac{1}{V}\left(-\frac{nRT}{P^2}\right) = +\frac{1}{V}\left(\frac{PV}{P^2}\right) = \frac{1}{P}$$

$$\beta = \frac{1}{P}$$

Correct option is (A)

4. (a)

Sol. $\frac{\Delta S}{\Delta V} = \frac{dP}{dT}$

$$\alpha = \frac{1}{V}\left(\frac{dV}{dT}\right)_P \qquad \beta = -\frac{1}{V}\left(\frac{dV}{dP}\right)_T$$

$$\frac{\alpha}{\beta} = \frac{\frac{1}{V}\left(\frac{dV}{dT}\right)_P}{-\frac{1}{V}\left(\frac{dV}{dP}\right)_T}$$

$$\frac{\alpha}{\beta} = -\left(\frac{dV}{dT}\right)_P\left(\frac{dP}{dV}\right)_T = \left(\frac{dP}{dT}\right)_V$$

Applying cyclic rule

$$\left(\frac{dP}{dV}\right)_T\left(\frac{dV}{dT}\right)_P\left(\frac{dT}{dP}\right)_V = -1$$

$\because$ $\frac{\Delta S}{\Delta V} = \frac{dP}{dT} = \frac{\alpha}{\beta}$

$\therefore \quad \Delta S = \frac{\alpha}{\beta}\Delta V$

Correct option is (a)

5. (d)

Sol. Let $V(T_1\ P)$

Applying cyclic rule

$$\left(\frac{\partial V}{\partial T}\right)_P \left(\frac{\partial T}{\partial P}\right)_V \left(\frac{\partial P}{\partial V}\right)_T = -1$$

Multiply and divide by V

$$\frac{V}{V}\left(\frac{\partial V}{\partial T}\right)_P \left(\frac{\partial T}{\partial P}\right)_V \left(\frac{\partial P}{\partial V}\right)_T = -1$$

$$+\frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_P \left[V\left(\frac{\partial T}{\partial P}\right)_V \left(\frac{\partial P}{\partial V}\right)_T\right] = -1$$

We know,

$$\alpha = +\frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_P$$

$$\therefore \quad \alpha\left[V\left(\frac{\partial T}{\partial P}\right)_V \left(\frac{\partial P}{\partial V}\right)_T\right] = -1$$

$$\alpha = -\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial V}{\partial P}\right)_T \times \frac{1}{V}$$

Multiply and divide by P

$$\alpha = -\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial V}{\partial P}\right)_T \times \frac{1}{V} \times \frac{P}{P}$$

$$\alpha = \gamma P\left[-\frac{1}{V}\left(\frac{\partial V}{\partial P}\right)_T\right] \qquad \left\{\because V = \frac{1}{P}\left(\frac{\partial P}{\partial T}\right)_V \quad \beta = -\frac{1}{V}\left(\frac{\partial V}{\partial P}\right)_T\right\}$$

$\alpha = \beta\gamma P$

Correct option is (D)

6. (c)

Sol. $P(V - nb) = nRT$

$PV - Pnb = nRT$

$$\alpha = \frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_P \text{ and } \beta = -\frac{1}{V}\left(\frac{\partial V}{\partial P}\right)_T$$

$$\left(\frac{\partial V}{\partial T}\right)_P = \frac{nR}{P} \text{ and } \left(\frac{\partial V}{\partial P}\right)_T = \frac{nb - V}{P}$$

$$\frac{\alpha}{\beta} = \frac{\frac{1}{V}\left(\frac{nR}{P}\right)}{-\frac{1}{V}\left(\frac{nb - V}{P}\right)} = \frac{(nR)(P)}{-(nb - V)(P)} = \frac{nR}{V - nb}$$

Correct option is (C)

7. (b)

Sol. $\beta = -\frac{1}{V}\left(\frac{\partial V}{\partial P}\right)$

Near the initial point, or in case of high pressure or low temperature, compressiblity factor strays far from unity, i.e. infinite.

Correct option is (b)

8. (a)

Sol. $\frac{q_{rev}}{T} = dS\,(\text{State function})$

$q_{rev} - W$ (State function)

$q_{rev} + P(dV)$ (State function)

Correct option is (A)

9. (a)

Sol. Thermodynamic process are the state functions & so is specified by specifying the initial & final state of the system.

P-V work is usually negligible in case of solid & liquid because of the small change in temperature which causes negligible change in the volume & pressure, hence external work performed is negligible.

Correct option is (a)

10. (b)

Sol. $P_1 = 5$ atm a $\quad P_{ext} = 1$ atm $\quad C_V = \frac{5}{2}R$

$V_1 = V_1 \quad V_2 = 2V_1$

$T_1 = 298\,k \quad T_2 = ?$

Consider the process to be irreversible.

$C_V(T_2 - T_1) = -P_{ext}(V_2 - V_1)$

$\frac{5}{2}R(T_2 - 298) = -1(2V_1 - V_1)$

$$\frac{5}{2}R\left(T_2-298\right)=-V_1$$

Also $P_1V_1=RT_1$

$$V_1=\frac{RT_1}{P_1}$$

$$\frac{5}{2}R\left(T_2-298\right)=-\frac{RT_1}{P_1}$$

$$\frac{5}{2}\left(T_2-298\right)=\frac{-298}{5}$$

$T_2=274.16\ k$

Correct option is (B)

11. (d)

Sol. $T_1=300\,k$ $P_1=0.507\ MPa$

$P_{ext}=0.101\ MPa$ $P_2=0.203\ MPa$

$$nC_V\left(T_2-T_1\right)=-P_{ext}\left(\frac{nRT_2}{P_2}-\frac{nRT_1}{P_1}\right)$$

$$2\left(2.5R\right)\left[T_2-300\right]=-0.101\,MPa\left[\frac{2RT_2}{0.203}-\frac{2R\left(300\right)}{0.507}\right]$$

On solving,

$T_2=270\ k$

Correct option is (D)

12. (a)

Sol. Adiabatic reversible expansion

$V_1=1.25\ L$

$V_2=2.5\ L$

$$C_V=\frac{3}{2}R \qquad C_P=\frac{5}{2}R$$

$$T_1V_1^{\gamma-1}=T_2V_2^{\gamma-1}$$

$$(300)(1.25)^{\gamma-1}=T_2(2.5)^{\gamma-1}$$

$$\frac{300}{T_2}=\left(\frac{2.5}{1.25}\right)^{\gamma-1}$$

$$\frac{300}{T_2}=2^{\frac{5}{3}-1}$$

$$\frac{300}{T_2} = 2^{2/3}$$

$$T_2 = 190 \text{ K}$$

$$n = \frac{PV}{RT} = \frac{1\times1.25}{0.0821\times300} = 0.05$$

$$dH = nC_P dT$$

$$= 0.05\times\frac{5}{2}R\times110$$

$$dH = 1153$$

Correct option is (c)

13. (c)

Sol. Monoatomic gas, $C_V = \frac{3}{2}R = 1.5R$

Irreversible process, Adiabatic process

$$C_V\left(T_2 - T_1\right) = -P_{ext}\left(V_2 - V_1\right)$$

$V_2 = 3L \quad V_1 = 1L \quad P_{ext} = 1$ atm

$$1.5R\left(T_2 - T\right) = -1\left(3-1\right)$$

$$\left(T_2 - T\right) = -\frac{2}{1.5R}$$

$$T_2 = -\frac{2}{1.5R} + T$$

$$T_2 = T - \frac{2}{1.5\times0.082} \quad \{R = 0.082\}$$

Correct option is (C)

14. (c)

Sol.

Monoatomic	Diatomic
T_i = initial temperature	T_i = Initial temperature
V_i = initial volume	V_i = initial volume
V_F = final volume	V_F = Final volume
T_M = final temperature	T_D = final temperature
$C_V = \frac{3}{2}R$	$C_V = \frac{5}{2}R$

Adiabatic reversible expansion

$$T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1}$$

$$\gamma - 1 = \frac{R}{C_V}$$

For monoatomic

$$\gamma - 1 = \frac{2R}{3R} = 0.66$$

$$(T_i)(V_i)^{0.66} = (T_M)(V_F)^{0.66}$$

$$T_i = T_M\left(\frac{V_F}{V_i}\right)^{0.66} \quad \text{... (1)}$$

For Diatomic

$$\gamma - 1 = \frac{2R}{5R} = 0.4$$

$$(T_i)(V_i)^{0.4} = T_D(V_F)^{0.4}$$

$$T_i = T_D\left(\frac{V_F}{V_i}\right)^{0.4} \quad \text{... (2)}$$

Equating Eq. (1) & Eq. (2)

$$T_M\left(\frac{V_F}{V_i}\right)^{0.66} = T_D\left(\frac{V_F}{V_i}\right)^{0.4}$$

$$T_D = T_M\left(\frac{V_F}{V_i}\right)^{0.66}\left(\frac{V_i}{V_F}\right)^{0.4}$$

$$T_D = T_M\left(\frac{V_F^{0.66}}{V_F^{0.4}}\right)\left(\frac{V_i^{0.4}}{V_i^{0.66}}\right)$$

$$T_D = T_M(V_F)^{0.26}(V_i)^{-0.26}$$

$$T_D = T_M\left(\frac{V_F}{V_i}\right)^{0.26}$$

$T_D > T_M$ (In case of expansion)

Correct option is (c)

15. (c)

Sol. Expansion, reversible and adiabatic process

$C_P - C_V = R$

$29.234 - C_V = 8.314\ Jk^{-1}\ mol^{-1}$

$C_U = (29.234 - 8.314)\,Jk^{-1}mol^{-1}$

$C_V = 20.92\ Jk^{-1}mol^{-1}$

$\gamma - 1 = \frac{R}{C_V} = \frac{8.314}{20.92} \approx 0.4$

Using formula,

$T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1}$

$(750)(1)^{0.4} = T_2(10)^{0.4}$

$T_2 \approx 300\,k$

Correct option is (C)

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DPP- 5 THERMODYNAMICS

1. In an adiabatic process, if q is the heat absorbed by the system and w is the work done on the system then

   (a) q = w (b) q = –w

   (c) du = w (d) du = q

2. Two moles of an ideal gas expand spontaneously into a vacuum. The work done is

   (a) 2 J (b) Infinity

   (c) zero (d) 4 J

3. The work done in increasing the temperature of 1 mole of gas by 2°C at constant pressure is

   (a) 2R (b) R

   (c) 3R (d) R/2

4. 2 moles of an ideal gas is expanded isothermally and reversibly from 1 L to 10 L at 300 K. What is the enthalpy change ?

   (a) 4.98 kJ (b) 11.47 kJ

   (c) –11.47 kJ (d) 0 kJ

5. For which of the following reactions is $\Delta H = \Delta U$

   (a) $C + O_2 \rightarrow CO_2$ (b) $C + \frac{1}{2} O_2 \rightarrow CO$

   (c) $N_2 + O_2 \rightarrow 2NO$ (d) $N_2O_4 + \frac{1}{2}O_2 \rightarrow N_2O_5$

6. For the combustion of 1 mole of CH_3COOH (l) at 25°C, Δn is

   (a) – 1 (b) 1

   (c) 0 (d) – 1/2

7. One mole of a perfect gas expands adiabatically. As a result of this, its pressure, temperature and volume change from p_1, T_1, V_1 to p_2, T_2 and V_2 respectively. if molar specific heat at constant volume is C_V, then the magnitude of work done by the gas is

   (a) $2.303 p_1 V_1 \log \frac{V_2}{V_1}$ (b) $RT_1 \log \frac{V_2}{V_1}$

   (c) $\frac{p_1^2 V_1^2 - p_2^2 V_2^2}{R(T_2 - T_1)}$ (d) $C_V (T_1 - T_2)$

8. For an ideal gas following adiabatic reversible expansion plot of log P vs log V is linear with a slope equal to

(a) $\frac{1}{\gamma}$ (b) $-\frac{1}{\gamma}$

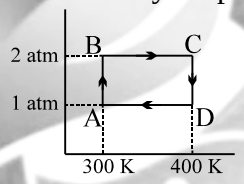
(c) γ (d) $-\gamma$

9. The internal energy of n moles of a gas is given $E = \frac{3}{2}nRT - \frac{a}{V}$, where V is the volume of the gas at temperature T and a is a positive constant. One mole of the gas in state (T_1, V_1) is allowed to expand adiabatically into vacuum to a final state (T_2, V_2). The temperature T_2 is

(a) $T_1 + \frac{a}{R}\left(\frac{1}{V_2} + \frac{1}{V_1}\right)$ (b) $T_1 - \frac{2}{3}\frac{a}{R}\left(\frac{1}{V_2} - \frac{1}{V_1}\right)$

(c) $T_1 + \frac{2}{3}\frac{a}{R}\left(\frac{1}{V_2} - \frac{1}{V_1}\right)$ (d) $T_1 - \frac{1}{3}\frac{a}{R}\left(\frac{1}{V_2} - \frac{1}{V_1}\right)$

10. Two moles of Helium gas undergo a reversible cyclic process as shown in figure. Assuming gas to be ideal, what is the net work involved in the cyclic process?



(a) –100 R*l*n4 (b) +100R*l*n4

(c) +200R*l*n4 (d) –200R*l*n4

11. The temperature of 2 moles of an ideal gas is raised from 300 K to 400 K. The value of $\Delta H - \Delta E$ for this process is

(a) 0 J (b) 83 J

(c) 830 J (d) 1660 J

12. The value of ΔU for the transformation of one mole of an ideal gas from 27°C and 1 atm to 327°C and 17 atm is (given that $C_P = 20.9 + 0.042\ T$ J/K-mole).

(a) 9.4 KJ/mole (b) 11.9 KJ/mole

(c) 21.3 KJ/mole (d) 2.5 KJ/mole

13. One mole of an ideal gas ($C_V = 1.5$ R) at a temp 500 K is compressed from 1.0 atm to 2.0 atm by a reversible isothermal path. Subsequently it is expanded back to 1.0 atm by reversible adiabatic path. The volume of final state in litre is

(a) 15.6 (b) 20.5

(c) 31.1 (d) 41.0

14. If a certain mass of gas is made to undergo separately adiabatic and isothermally expansion to the same pressure, starting from the same initial condition of temperature and pressure, then, as compared to that of isothermal expansion, in the case of adiabatic expansion, the final

(a) Volume and temperature will be higher.

(b) volume and temperature will be lower

(c) temperature willbe lower but the final volume will be higher

(d) volume will be lower but the final temperature will be higher

15. 1 mole of an ideal gas expands in volume reversible and isothermally from initial volume of 1 litre to 10 litre the enthalpy change for this process is

(a) 5.7 KJ (b) –5.7 KJ

(c) 0 (d) 2.4 KJ

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ANSWER KEY

1. (c)	7.(d)	13.(c)
2.(c)	8.(d)	14.(b)
3.(a)	9.(b)	15. (c)
4.(d)	10.(a)	
5.(c)	11.(d)	
6.(c)	12.(a)	

HINTS & SOLUTIONS

1. (c)

Sol. Are to 1st low of thermodynamics,

$dU = w + q$

$\because$ Adiabatic process, $\therefore$ $q = 0$

$dU = w$

Correct option is (C)

2.(c)

Sol. In vaccum, (Free expansion)

$P_{ext} = 0$

Then, work done = 0

Correct option is (C)

3.(a)

Sol. $\because$ Heat required to raise the temperature by 1^oC = R = work done

Work done when the temperature is raised to 2^oC = 2R.

Correct option is (A)

4.(d)

Sol. The process is isothermal

$\therefore$ Enthalpy charge = 0

When the process is isothermal, then both enthalpy change interval change will be zero because both H and U are the function of temperature only.

Correct option is (D)

5.(c)

Sol. $\Delta H = \Delta U + \Delta n_g RT$

When $\Delta H = \Delta U$ then $\Delta n_g = 0$ because R and T can never be zero.

(a) $C + O_2 \rightarrow CO_2$ $\qquad \Delta n_g = 1-(1+1) = -1$

(b) $C + \frac{1}{2}O_2 \rightarrow CO$ $\qquad \Delta n_g = 1-\left(1+\frac{1}{2}\right) = -1/2$

(c) $N_2 + O_2 \rightarrow 2NO$ $\qquad \Delta n_g = 2-(1+1) = 0$

(d) $N_2O_4 + \frac{1}{2}O_2 \rightarrow N_2O_5$ $\qquad \Delta n_g = 1-\left(1+1/2\right) = -1/2$

Correct option is (C)

6.(c)

Sol. $CH_3COOH\ (l) + O_2(g) \rightarrow CO_2 + 2H_2O\ (l)$

$$\Delta n_g = \begin{pmatrix}\text{Stioch. of product in}\\ \text{gaseous phase}\end{pmatrix} - \begin{pmatrix}\text{Stioch. of reactant in}\\ \text{gaseous phase}\end{pmatrix}$$

$= 1 - 1$

$\Delta n_g = 0$

Correct option is (C)

7.(d)

Sol. The process is adiabatic expansion.

In expansion, $T_1 > T_2$

and $\Delta U = q + w$ (1^{st} law)

q = 0 (adiabatic process)

$\Delta U = w$

$\Delta U = C_V\left(T_1 - T_2\right)$

$w = C_V\left(T_1 - T_2\right) \qquad \{T_1 > T_2\}$

Correct option is (D)

8.(d)

Sol. In adiabatic reversible expansion

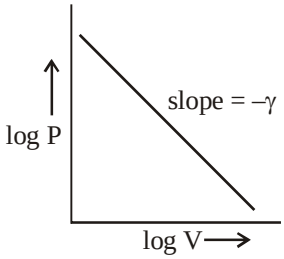
$PV^{\gamma} = \text{constant}$

$\log P + \gamma \log V = \text{constant}$

$\log P = \text{constant} - \gamma \log V$

$y = C + m x$

Slope $= -\gamma$



Correct option is (D)

9.(b)

Sol. $E = \frac{3}{2}nRT - \frac{a}{V}$

for adiabatic q = 0

Expansion in vaccume to = 0

First law of thermodynamics

$q + W = \Delta E$

$\because \quad \Delta E = 0$

$E_1 = E_2$

$$\frac{3}{2}nRT_1 - \frac{a}{V_1} = \frac{3}{2}nRT_2 - \frac{a}{V_2}$$

$$\Rightarrow \; T_2 = T_1 + \frac{2}{3}\frac{a}{R}\left(\frac{1}{V_2} - \frac{1}{V_1}\right)$$

10.(a)

Sol. $n = 2$ $\qquad PV = RT$

$B \to C$ $\qquad W_1 = -P_{ext}dV$ $\qquad P \propto \frac{1}{V}$

$= -nRT\frac{dV}{V}$ $\qquad P_1V_1 = P_2V_2$

$W_1 = 0,\ P_1 = P_2$ $\qquad \frac{V_2}{V_1} = \frac{P_1}{P_2}$

$C \to D$ $\qquad W_2 = 2 \times R \times 400 \ln \frac{1}{2}$

$= +800\ R \ln 2$

$W_3 = 0$

$W_4 = -2 \times R \times 300 \ln \frac{2}{1}$

$= 600\ R \ln 2$

$W_F = W_1 + W_2 + W_3 + W_4$

$= 200\ R \ln 2$

Correct option is (c)

11.(d)

Sol. $\Delta H = \Delta E + n_g R\Delta T$

$\Delta H - \Delta E = nR\Delta T$

$\Delta H - \Delta E = (2)(8.314)(400 - 300)$

$\Delta H - \Delta E = 1660\,J$

Correct option is (D)

12.(a)

Sol. $T_1 = 300$ K

$P_1 = 1$ atm $\quad V_1 = 24.3$ L

$P_2 = 17$ atm $\quad V_2 = 2.89$ L

$C_P = 20.9 + 0.042\ T$

$C_V = 12.58 + 0.042\ T$

$\Delta U = C_V dT$

$= (12.587 + 0.042\ T)\ dT$

$\Delta U = 12.587dT + 0.042TdT$

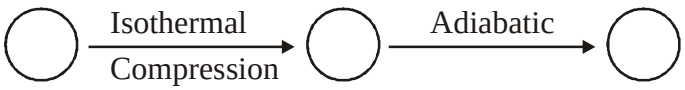
$\Delta U = 12.58(T_2 - T_1) + \frac{0.042}{2}(T_2^2 - T_1^2)$

$\Delta U = 12.58(600 - 300) + 0.021[(600)^2 - (300)^2]$

$\Delta U = 9.4kJ$

Correct option is (a)

13.(c)

Sol. 

$P_1 = 1$ atm $\quad P_2 = 2$ atm $\quad V_2 = ?$

$T = 500$ k $\quad V_1 = ?$ $\quad P = 1$ atm

$PV = nRT$

$P_2V_1 = nRT$

$V_1 = \frac{1 \times 0.0821 \times 500}{2} = 20.525$

$P_1V_1^{\gamma} = P_2V_2^{\gamma}$

$C_V = 1.5\,R$ $\qquad$ $C_P = C_V + R$

$C_P = 1.5\,R + R = 2.5\,R$

$\gamma = \dfrac{C_P}{C_V} = \dfrac{2.5\,R}{1.5\,R} = 1.66$

$(2)(20.52)^{1.66} = (1)(V_2)^{1.66}$

$V_2 = 31.1$

Correct option is (C)

14.(b)

Sol. Adiabatic expansion,

The final volume and temperature will be lower than that of isothermal pansion.

In expansion, adiabatic $\rightarrow$ cooling because $T_2 < T_1$

$T_{iso} > T_{adiabatic}$

For volume $P_1\ V_1\ T_1$ — Iso. → $P_2\ V_2\ T_1$

$P_1\ V_1\ T_1$ — Adiabatic → $P_2'\ V_2'\ T_1$

Isothermal	P decrease	V increase	
Adiabatic	P decrease	V increase	There will be less increase in volume
	T decrease	V decrease	

$\therefore\ V_{adiabatic} < V_{isothermal}$

15. (c)

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DPP- 6 THERMODYNAMICS

1. Incorrect statement from the following are

(a) Work appears only at the boundary of the system

(b) For liquid and solid the value of $\left(\frac{\partial U}{\partial V}\right)_T$ is zero

(c) Work involved in reversible isothermal expansion of an ideal gas is less than that in irreversible process.

(d) In adiabatic compression of an ideal gas temperature increases

2. The internal pressure $\pi_T = T\left(\frac{\partial P}{\partial T}\right)_V - P$ for one mole of vanderwall gas is

(a) $\frac{a}{V^2}$ (b) $\frac{a}{V^2}\left(\frac{RT}{V-b}\right)$ (c) zero (d) $\frac{RT}{V-b}$

3. The internal pressure of a vander waals gas is

(a) Independent of the molar volume

(b) Inversely propotional to the molar volume

(c) Inversely proportional to square of the molar volume

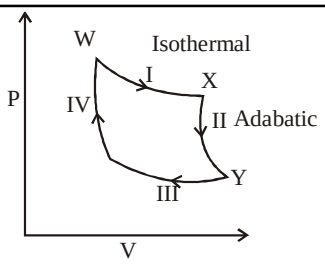
(d) directly propotional to the molar volume

4. The internal pressure $\left(\frac{\partial U}{\partial V}\right)_T$ of a real gas is related to the compressibility factor $Z = \frac{p\bar{V}}{RT}$ by [$\bar{V}$ is the molar volume]

(a) $\left(\frac{\partial U}{\partial V}\right)_T = RT\left(\frac{\partial Z}{\partial V}\right)_T$ (b) $\left(\frac{\partial U}{\partial V}\right)_T = \frac{RT}{(\bar{V}Z)}$

(c) $\left(\frac{\partial U}{\partial V}\right)_T = \left(\frac{RT^2}{\bar{V}}\right)\left(\frac{\partial Z}{\partial T}\right)_V$ (d) $\left(\frac{\partial U}{\partial V}\right)_T = \left(\frac{\bar{V}}{RT^2}\right)\left(\frac{\partial Z}{\partial T}\right)_V$

5. From the given figure of carnot cycle (by an ideal gas) identify the process in which the change in internal energy is non zero.



(a) I & II (b) II & IV (c) II & III (d) I & IV

6. The maximum efficiency of an engine operating between 110°C and 25°C will be

(a) 30.5% (b) 20.25% (c) 22.20% (d) 33.3%

7. A carnot engine operating between 127°C and 527°C absorbs 500 J of heat from the high temperature source the maximum efficiency of the engine

(a) 0.53 (b) 0.75 (c) 0.87 (d) 0.50

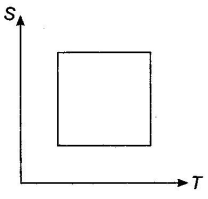
8. A carnot engine operates between 600 K and 800 K and absorbs 2000 calories from the source per cycle. The work done (in cal) per cycle is

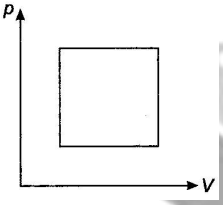
(a) 1000 (b) 500 (c) 666 (d) 2000

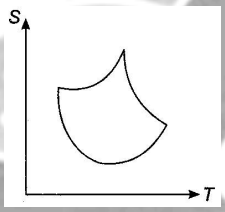
9. The coefficient of performance of refrigerator working reversibly between the temperature T_C and T_h is given by

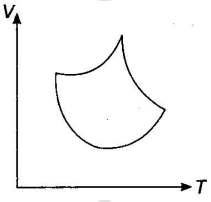
(a) $\frac{T_C - T_h}{T_C}$ (b) $\frac{T_h - T_C}{T_C}$ (c) $\frac{T_C}{T_h - T_C}$ (d) $\frac{T_h}{T_h - T_C}$

10. The plot that describes a carnot cycle is

(a) 

(b) 

(c) 

(d) 

11. A carnot takes up 90 J of heat from the source kept at 300 K. The correct statement among the following is

(a) It transfers 60 J of heat to the sink at 200 K

(b) It transfers 50 J of heat to the sink at 200 K

(c) It transfers 60 J of heat to the sink at 250 K

(d) It transfers 50 J of heat to the sink at 250 K

12. In a reversible cycle, the value of the integral $\oint \frac{dQ}{T}$ is

(a) $\oint \frac{dQ}{T} > 0$ (b) $\oint \frac{dQ}{T} < 0$ (c) $\oint \frac{dQ}{T} = 0$ (d) $\oint \frac{dQ}{T} = \text{constant}$

13. What percentage T_1 is of T_2 for a 10 per cent efficiency of a heat engine ?

(a) 10 (b) 70 (c) 90 (d) 40

14. Which of the following thermodynamic functions have been called "the arrow of time"

(a) enthalpy (b) Gibbs free energy

(c) Entropy (d) Helmholtz free energy.

15. Among the following, the reaction that is accompanied by a decrease in the entropy is

(a) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ (b) $C_6H_{12}O_6(s) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l)$

(c) $PCl_5(s) \rightarrow PCl_3(l) + Cl_2(g)$ (d) $2H_2O\ (l) \rightarrow 2H_2(g) + O_2(g)$

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ANSWER KEY

1. c
2. a
3. c
4. c
5. b
6. c
7. d
8. b
9. c
10. a
11. a
12. c
13. c
14. c
15. a

HINTS & SOLUTIONS

1. c

Sol. $(\text{Work})_{\text{reversible}} > (\text{Work})_{\text{irreversible}}$

Correct option is (c)

2. a

Sol. $\pi_T = T\left(\frac{\partial P}{\partial T}\right)_V - P$

Vanderwaale gas, $\left(P + \frac{a}{V^2}\right)(V - b) = RT$

$$P = \frac{RT}{V-b} - \frac{a}{V^2} \quad \ldots (1)$$

$$\left(\frac{\partial P}{\partial T}\right)_V = \frac{R}{V-b}$$

$$\pi_T = T\left(\frac{R}{V-b}\right) - P$$

$$= T\left(\frac{R}{V-b}\right) - \left(\frac{RT}{V-b} - \frac{a}{V^2}\right) \qquad \{\text{from equation } (1)\}$$

$$= \frac{RT}{V-b} - \frac{RT}{V-b} + \frac{a}{V^2}$$

$$\pi_T = \frac{a}{V^2}$$

Correct option is (A)

3. c

Sol. Interval pressure $\pi_T = \frac{a}{V^2}$

Inversly proportional to square of the molar volume.

Correct option is (C)

4. c

Sol. $\left(\frac{dU}{dV}\right)_T = T\left(\frac{dP}{dT}\right)_V - P$ $\qquad Z = \frac{PV}{RT}$ ... (1)

$$= T\frac{d}{dT}\left(\frac{ZRT}{V}\right) - P \qquad P = \frac{ZRT}{V}$$

$$\left(\frac{dP}{dT}\right)_V = \frac{d}{dT}\left(\frac{ZRT}{V}\right)$$

$$= \frac{R}{V}\left\{T\left(\frac{dZ}{dT}\right)_V + Z\right\}$$

Put this in equation (1)

$$\left(\frac{dU}{dV}\right)_T = \frac{RT^2}{V}\left[\frac{dZ}{dT}\right]_V$$

5. b

Sol. $\Delta U \neq 0$

In adiabatic process

$\Delta U \neq 0$

Process II and IV

Correct option is (B)

6. c

Sol. $n = 1 - \frac{T_c}{T_h}$

$T_c = 298$ k $\qquad T_h = 383$ k

$n = 1 - \frac{298}{383} = 1 - 0.77 = 0.23 = 23\%$

Correct option is (B)

7. d

Sol. $T_c = 127^oC = 400$ k

$T_h = 527^oC = 800$ k

$n = 1 - \frac{400}{800} = 0.5$

Correct option is (d)

8. b

Sol. $n = 1 - \frac{600}{800}$

$= 1 - \frac{3}{4} = \frac{4-3}{4} = \frac{1}{4} = 25\%$

Workdone = 25% of 2000 = 500 J

Correct option is (B)

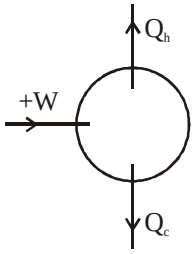
9. c

Sol. $\beta = \frac{\text{Output}}{\text{Input}} = \frac{Q_c}{W}$

$\beta = \frac{Q_c}{Q_h - Q_c} = \frac{T_c}{T_h - T_c}$

$\frac{1}{\beta} = \frac{T_h - T_c}{T_c} = \frac{T_h}{T_c} - 1$

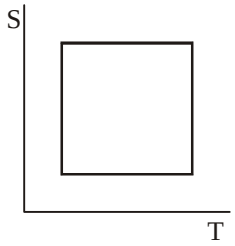
$\beta = \frac{T_c}{T_h - T_c}$



Correct option is (B)

10. a

Sol.



Correct option is (A)

11. a

Sol. (a) It transfer 60J of heat to the sink and usuable heat µ 30J i.e., 33% of initial amount

$$n = 1 - \frac{200}{300} = 1 - 0.66 = 0.33 = 33\%$$

(c) $n = 1 - \frac{250}{300} = 16\%$

12. c

Sol. Cyclic integral of path function is zero.

So, $\oint \frac{dQ}{T} = 0$

Correct option is (C)

13. c

Sol. $\frac{10}{100} = 1 - \frac{T_1}{T_2}$

$\Rightarrow \frac{T_1}{T_2} = 1 - \frac{1}{10} = \frac{9}{10}$

$T_1 = 0.9\ T_2$

i.e. when $T_1 = 10$ k

$T_2 = 9$ k

i.e., 90%

Correct option is (C)

14. c

Sol. The arrow of time is Entropy Based on our universe is continuously expanding, which result incresing the $\Delta S > O$.

15. a

Sol. Entropy decrease

$\rightarrow$ (1) When moler increase

$\rightarrow$ (2) S $\rightarrow$ g.

Only option (a) in which moler increase i.e., why entropy increase.

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DPP- 7 THERMODYNAMICS

1. Which of the following are the set of state functions?
   (a) w, q, T (b) P, V, T (c) w, q, C_v (d) C_p, C_v, q
2. The state of the thermodynamic system is specifical by which of the following vacuables?
   (a) P, V, T, time (b) P, V, T, mass, surface area
   (c) Work and heat (d) n, x and length
3. Which out of them are extrinsic variables/
   (a) T, P, V_m (b) Emf, specific heat capacitor, vapour pressure
   (c) Mass, length, volume (d) Density, enthalpy, intropy
4. In thermodynamics of open system thermodynamic parameter included are
   (a) T, P, V, S (b) T, P, V, S, n (c) T, P, n (d) n only
5. The thermodynamic potential which must be negative for spontaneous process at constant themperature and at consttant pressure
   (a) G (b) H (c) A (d) U
6. The exact differential of a state function f(x, y) among the following is
   (a) xdy (b) $dx - \frac{x}{y}dy$ (c) ydx – xdy (d) $\frac{1}{y}dx - \frac{x}{y^2}dy$
7. For a process in a closed system, temperature is equal to
   (a) $\left(\frac{\partial H}{\partial P}\right)_S$ (b) $-\left(\frac{\partial A}{\partial V}\right)_T$ (c) $\left(\frac{\partial G}{\partial P}\right)_T$ (d) $\left(\frac{\partial H}{\partial S}\right)_P$
8. Consider an ideal gas of volume V at temperature T and pressure P. If the entropy of the gas is S, the partial derivative $(\delta P/\delta S)_V$ is equal to
   (a) $(\delta T/\delta P)_S$ (b) $(\delta T/\delta V)_P$ (c) $(\delta T/\delta V)_S$ (d) $(\delta T/\delta S)_P$
9. From Maxewell thermodynamic relation, the value of P may be obtained in terms of first partial derivatives of thermodynamic potential
   (a) G, U (b) G, A (c) A, U (d) H, U
10. The correct thermodynamic relations among the following is
    (a) $(\partial U/\partial V)_S = -P$ (b) $(\partial H/\partial V)_S = -P$ (c) $(\partial G/\partial V)_S = -P$ (d) $(\partial A/\partial V)_S = -S$

11. Which one of the following defines the absolute temperature of a system?

(a) $\left(\partial U/\partial S\right)_V$ (b) $\left(\partial A/\partial S\right)_V$ (c) $\left(\partial H/\partial S\right)_V$ (d) $\left(\partial G/\partial S\right)_V$

12. The value of $(\delta G/\delta T)_P$ is equal to

(a) $\left(\delta A/\delta T\right)_V$ (b) $\left(\delta A/\delta V\right)_T$ (c) $\left(\delta U/\delta T\right)_V$ (d) $\left(\delta A/\delta T\right)_P$

13. The value of $(\delta S/\delta P)_T$ is equal to

(a) $\left(\delta V/\delta T\right)_P$ (b) $-\left(\delta V/\delta P\right)_T$ (c) $-\left(\delta V/\delta T\right)_P$ (d) $\left(\delta V/\delta P\right)_T$

14. The change in Enthalpy with respect to change in pressure at constant entropy is equal to

(a) Themperature (b) Volume (c) Pressure (d) Entropy

15. The change in internal energy with respect to change in entropy at constant volume is

(a) Pressure (b) Volume (c) Temperature (d) Entropy

16. The change in value of thermodynamic potential G with respect to P at constant temperature is

(a) V (b) –S (c) P (d) –V

17. Indicate which one of the following relations is NOT correct.

(a) $-\left(\frac{\partial T}{\partial V}\right)_S=\left(\frac{\partial P}{\partial S}\right)_V$ (b) $-\left(\frac{\partial T}{\partial P}\right)_S=-\left(\frac{\partial V}{\partial S}\right)_P$

(c) $-\left(\frac{\partial S}{\partial V}\right)_T=-\left(\frac{\partial P}{\partial T}\right)_V$ (d) $-\left(\frac{\partial S}{\partial P}\right)_T=\left(\frac{\partial V}{\partial T}\right)_P$

18. Indicate which one of following relation is incorrect.

(a) $-\left(\frac{\partial T}{\partial V}\right)_S=\left(\frac{\partial P}{\partial S}\right)_V$ (b) $-\left(\frac{\partial T}{\partial P}\right)_S=\left(\frac{\partial V}{\partial S}\right)_P$

(c) $-\left(\frac{\partial S}{\partial V}\right)_T=-\left(\frac{\partial P}{\partial T}\right)_V$ (d) $-\left(\frac{\partial S}{\partial P}\right)_T=\left(\frac{\partial V}{\partial T}\right)_P$

19. The correct thermodynamic relation among the following is?

(a) $\left(\frac{\partial U}{\partial V}\right)_S=-P$ (b) $\left(\frac{\partial H}{\partial V}\right)_S=--P$ (c) $\left(\frac{\partial G}{\partial V}\right)_S=-P$ (d) $\left(\frac{\partial A}{\partial V}\right)_S=-S$

20. The partial derivative $\left(\frac{\partial T}{\partial V}\right)_P$ is equal to

(a) $-\left(\frac{\partial P}{\partial S}\right)_V$ (b) $-\left(\frac{\partial P}{\partial S}\right)_V$ (c) $-\left(\frac{\partial P}{\partial S}\right)_n$ (d) $-\left(\frac{\partial P}{\partial S}\right)_n$

21. For a system of constant composition, pressure (P) given by?

(a) $-\left(\frac{\partial U}{\partial S}\right)_V$ (b) $-\left(\frac{\partial U}{\partial V}\right)_S$ (c) $\left(\frac{\partial V}{\partial S}\right)_T$ (d) $\left(\frac{\partial U}{\partial V}\right)_T$

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ANSWER KEY

1. (b)
2. (b)
3. ( )
4. (b)
5. (a)
6. (d)
7. (d)
8. (c)
9. (c)
10. (a)
11. (a)
12. (a)
13. (c)
14. (b)
15. (c)
16. (a)
17. (b)
18. (b)
19. (a)
20 (a)
21. (b)

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DPP- 8 THERMODYNAMICS

1. Consider the following statements:
(i) System said to be in thermal equilibrium when the is no heat flow from 1 portion of system to other
(ii) System is said to be in chemical equilibrium, when composition of various phases in the system remains same.
(a) (i) is true (b) (i), (ii) both true (c) All false (d) (ii) true

2. As per cyclic rule $\left(\frac{\partial z}{\partial x}\right)_y \left(\frac{\partial x}{\partial y}\right)_z \left(\frac{\partial y}{\partial z}\right)_x =$
(a) 0 (b) 1 (c) –1 (d) ∞

3. As per cyclic rule, $\left(\frac{\partial P}{\partial V}\right)_T \left(\frac{\partial V}{\partial T}\right)_P \left(\frac{\partial T}{\partial P}\right)_V = ?$
(a) –1 (b) 1 (c) 0 (d) ∞

4. For one mole of an ideal gas $\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial V}{\partial T}\right)_P \left(\frac{\partial V}{\partial P}\right)_T = ?$
(a) –1 (b) $\frac{-R^2}{P^2}$ (c) +1 (d) $\frac{R^2}{P^2}$

5. According to the cyclic rule, $\left(\frac{\partial P}{\partial V}\right)_T \left(\frac{\partial V}{\partial T}\right)_P \left(\frac{\partial T}{\partial P}\right)_V$ is equal to
(a) 0 (b) positive (c) negative (d) infinity.

6. For an ideal gas
(a) $\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial T}{\partial V}\right)_P \left(\frac{\partial V}{\partial P}\right)_T = 0$ (b) $\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial T}{\partial V}\right)_P \left(\frac{\partial V}{\partial P}\right)_T = -1$
(c) $\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial T}{\partial V}\right)_P \left(\frac{\partial V}{\partial P}\right)_T = +1$ (d) $\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial T}{\partial V}\right)_P \left(\frac{\partial V}{\partial P}\right)_T = +2$

7. Which of the following are intensive _____
(a) density, reprective index (b) volume, amount
(c) mass, temperature (d) volume

8. In a quasiequilibrium process, the pressure in a system
(a) remains constant (b) varies with temperature
(c) is everywhere constant at an instant (d) increases if volume increases

9. Which of the following is not an extensive property
(a) Momentum (b) Kinetic energy (c) Density (d) Mass

10. Which of the following is a state function
(a) Internal energy (b) Heat (c) Work (d) None of the above

11. Which of the following is an extensive property?
(a) Enthalpy (b) Concentration (c) Density (d) Viscosity

12. Identify the intensive property among the following
(a) Refractive index (b) Viscosity (c) Temperature (d) Volume

13. Which of the following are the set of state functions?
(a) W, q, T (b) P, V, T (c) W, Q, C_v (d) C_p, C_v, q

14. Which of the following functions are path dependent?
(a) Work done by conservative forces (b) Volume
(c) Temperature (d) Work done by thermodynamic system

15. What is the value of isothermal compressibility factor β for ideal gas [n = 1]
(a) $\frac{1}{T}$ (b) $\frac{1}{P}$ (c) $\frac{1}{V}$ (d) 1

16. The value of isothermal compressibility factor β for n mole of an ideal gas
(a) $\frac{1}{P}$ (b) $\frac{n}{P}$ (c) $\frac{1}{P^2}$ (d) $\frac{-1}{P^2}$

17. The entropy change in terms of α, β and ΔV is
(a) $\Delta S = \frac{\alpha \Delta V}{\beta}$ (b) $\Delta S = \frac{\alpha\beta}{\Delta V}$ (c) $\Delta S = \frac{1}{\alpha\beta\Delta V}$ (d) can not determine

18. The relation between α, β, γ and P is
(a) $\alpha\beta = \gamma P$ (b) $\alpha\gamma = \beta P$ (c) $\alpha\beta\gamma = P$ (d) $\alpha = \beta\gamma P$

19. The value of $\frac{\alpha}{\beta}$ for $P(V - nb) = nRT$ is
(a) $\frac{R}{V - nb}$ (b) $\frac{nR}{V - b}$ (c) $\frac{nR}{V - nb}$ (d) $\frac{nR}{V}$

20. The criterion for spontaneous change in terms of the state functions is
(a) $dU_{S, V} \geq 0$ (b) $dA_{T, V} \geq 0$ (c) $dS_{U, V} \geq 0$ (d) $dG_{P, V} \leq 0$

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ANSWER KEY

1. (d)
2. (c)
3. (a)
4. (b)
5. (c)
6. (b)
7. (a)
8. (c)
9. (c)
10. (a)
11. (a)
12. (d)
13. (b)
14. (a)
15. (b)
16. (a)
17. (a)
18. (d)
19. (c)
20. (d)

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DPP- 9 THERMODYNAMICS

1. In thermodynamics a process is called reversible
   (a) Surrounding and system change into one another
   (b) There is not boundary between system and surrounding
   (c) The surrounding are always in equilibrium with system
   (d) The system change in surrounding spontaneously

2. The value of internal pressure for 1 mole of an real gas with equation P(V – b) = RT is equal to
   (a) 0 (b) R (c) > R (d) < R

3. Consider the statement
   (i) For liquid and solid the value of $(\delta U/\delta V)_T$ is zero.
   (ii) for P(v-b) = RT the value of internal pressure is zero.
   (iii) If dZ = xdy + ydx than z is a state function.
   The true statements above are
   (a) (i), (ii) (b) (ii), (iii) (c) (i), (iii) (d) All

4. Consider the statements
   (i) U remains constant in every isothermal process in closed system
   (ii) if q = 0 then the process must be isothermal
   (iii) C_V is independent of volume in case of ideal gas.
   The true statements above are
   (a) (i), (ii) (b) (i), (ii), (iii) (c) (i) only (d) (iii) only

5. The internal pressure $\left(\frac{\partial U}{\partial V}\right)_T$ of a real gas is related to compressibility factor $Z = P\bar{V}/RT$ by

   (a) $\left(\frac{\partial U}{\partial V}\right)_T = RT\left(\frac{\partial Z}{\partial V}\right)_T$ (b) $\left(\frac{\partial U}{\partial V}\right)_T = \frac{RT}{(\bar{V}z)}$

   (c) $\left(\frac{\partial U}{\partial V}\right)_T = \left(\frac{RT^2}{\bar{V}}\right)\left(\frac{\partial Z}{\partial T}\right)_V$ (d) $\left(\frac{\partial U}{\partial V}\right)_T = \left(\frac{\bar{V}}{RT^2}\right)\left(\frac{\partial Z}{\partial T}\right)_V$

6. The internal pressure $pT = \{T(\delta P/\delta T)_V - P\}$ for one mole of vanderwall gas is
(a) a/V^2 (b) $(a/V^2)(RT/V - b)$ (c) zero (d) (RT/V-b)

7. The value of $(\delta H/\delta P)_T$ in terms of thermal expansivity α is
(a) $V(1 - \alpha T)$ (b) $V(1 + \alpha T)$ (c) $V(1 - \alpha/T)$ (d) $(1 - \alpha T)$

8. If U is the function of V and T, $(\delta U / \delta T)_P$ is equal to {π and α are the internal pressure and the coefficient of thermal expansion respectively}
(a) C_P (b) C_V (c) $C_P - \pi V\alpha$ (d) $CP + \pi V\alpha$

9. Internal energy of an ideal gas depends on:
(a) Pressure (b) Volume (c) Temperature (d) All

10. The value of $\{\delta C_V / \delta V\}_T$ for ideal gas is
(a) > 1 (b) < 1 (c) 0 (d) 1

11. The value of $(\delta H/\delta T)_V$ in terms of α and β is
(a) $C_V + \alpha V/\beta$ (b) $C_V - \alpha V/\beta$ (c) $C_V + \alpha/\beta$ (d) $C_V + \alpha V\beta$

12. The temperature of 2 moles of an ideal gas is raised from 300 K to 400 K. The value of $\Delta H - \Delta E$ for this process is
(a) 0 J (b) 83 J (c) 830 J (d) 1600 J

13. Among the following the system that would require least amount of thermal energy to bring its temperature to 80ºC is
(a) 200 gm of water at 40ºC (b) 100 gm of water at 20ºC
(c) 150 gm of water at 50ºC (d) 300 gm of water at 30ºC

14. Work done in increasing the temperature of gas by 2ºC at constant pressure is
(a) 2R (b) R (c) 3R (d) R/2

15. The work involved in reversible isothermal expansion of an ideal gas is
(a) $w = -nRT, \ln (V_f / V_i)$ (b) $w = nRT \ln (V_f / V_i)$
(c) $w = -nRT (V_f / V_i)$ (d) $w = -nRT \log (V_f / V_i)$

××××××

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ANSWER KEY

1. (c)
2. (a)
3. (b)
4. (d)
5. (c)
6. (a)
7. (a)
8. (d)
9. (c)
10. (b)
11. (a)
12. (d)
13. (c)
14. (a)
15. (a)

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DPP- 10 THERMODYNAMICS

1. The molar heat capcity of a substance is represented in the temperature range 298 K to 400 K by the empircal relation, C_p = 14 bT JK^{-1} mol^{-1}, where b is a constant. The molar enthalpy change when the substance is heated from 300 K to 350 K is 2 kJ mol^{-1}. The value of b is ___ JK^{-2} mol^{-1} (Upto two decimal places).

   (a) 0.08 (b) 0.07 (c) 0.05 (d) None

2. The CORRECT expression that corresponds to reversible and adiabatic expansion of an ideal gas is

   (a) $\Delta U = 0$ (b) $\Delta H = 0$ (c) $\Delta S = 0$ (d) $\Delta G = 0$

3. During isothermal expansion of an ideal which of the following happen

   (i) Temperature does not change

   (ii) Process is spontaneous

   (iii) The energy of the system does not change

   (iv) Entropy increases

   (a) (i) and (iii) only (b) (i), (ii) and (iii) only

   (c) (i), (iii) and iv only (d) (i), (ii), (iii) and (iv)

4. For a gas that obeying following equation of state P(V - b) = RT, b is a constant and R is universal gas constant, which of the folowing is right

   (a) $\left[\delta U / \delta V\right]_T = b$ (b) $\left[\delta U / \delta V\right]_T = R$

   (c) $\left[\delta U / \delta V\right]_T = P$ (d) $\left[\delta U / \delta V\right]_T = 0$

5. Heat capacity of a species is indepdnent of temperature if it is

   (a) tetraatmic (b) triatmic (c) diatomic (d) monoatomic

6. How many normal mode does the CO_2 molecule have? What if the C and O atom were constrained to move in 1 dimension.

   (a) 4 Normal mode for free CO_2 and 4 for Constrained CO_2

   (b) 3 Normal mode for free CO_2 and 4 for Constrained CO_2

   (c) 4 Normal mode for free CO_2 and 3 for Constrained CO_2

   (d) 4 Normal mode for free CO_2 and 2 for Constrained CO_2

7. An ideal gas consists of three dimensional polyatomic molecules. The temperature is such that only one vibrational mode is exicted. If R deonte the gas constant, then the specific heat at constant volume of one mole of the grins at this temperature is

(a) 3R (b) 7/2 R (c) 4R (d) 9/2 R

8. The equation of state for one mole of a non-deal gas is given by PV = A(1 + B/v), where the coefficientts A and B are tempertaure dependent. If the volume changes from V_1 to V_2 in an isothermal process, the work done by the gas is

(a) $AB\left(\frac{1}{V_1}-\frac{1}{V_2}\right)$ (b) $AB\ln\left(\frac{V_2}{V_1}\right)$

(c) $A\ln\left(\frac{V_2}{V_1}\right)+AB\left(\frac{1}{V_1}-\frac{1}{V_2}\right)$ (d) $A\ln\left(\frac{V_2-V_1}{V_1}\right)+B$

9. The heat capacity of colourless gas is 25 J/K-mole at room temperature probabbly the gas is

(a) H_2 (b) N_2 (c) CO_2 (d) sO_2

10. The value of γ is independent of temperature in caase of

(a) Monoatomic (b) Diatomic (c) Triatomic (d) Always

11. The 2 mole of an idaeal gas is expanded reverisbly and isothermally from 1 atm to 10 atom the work involved in this process is

(a) 2.303 RT (b) 4.606RT (c) 6.909 RT (d) 2RT

12. Q if internal energy for an ideal gas is related with the P and volume by the relation U = 3PV than the Poisssion equation in terms of Temperature and volume is

(a) TV^3 = Constant (b) TV^2 = Constant

(c) $TV^{1/3}$ = Constant (d) TV2/3 = Constant

13. For CO_2 molecule the energy according to equipartition law of energy is

(a) 3.5 kT (b) 4.5 kT (c) 6.5 kT (d) 5.5 kT

14. The value of ΔE and ΔH, when 100 dm^3 of helium at STP are heated to 373 in a vessel, Assuming that gas behave ideally and its C_V is 12.55 J/K-mole, respectively are

(a) 5.2 KJ and 9.3 KJ (b) 4.2 KJ and 8.6 KJ

(c) 10.2 KJ and 14.4 KJ (d) 12.3 KJ and 16.5 KJ

15. The number of normal modes of vibration in napthalene is

(a) 55 (b) 54 (c) 48 (d) 49

××××××

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ANSWER KEY

1.	(a)	8.	(c)	15.	(c)
2.	(c)	9.	(d)		
3.	(b)	10.	(a)		
4.	(d)	11.	(b)		
5.	(d)	12.	(c)		
6.	(d)	13.	(c)		
7.	(d)	14.	(a)		

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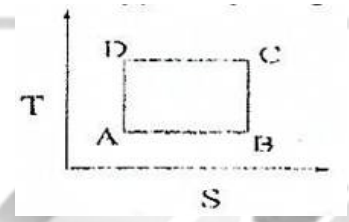
DPP- 11 THERMODYNAMICS

1. If the Carnot cycle in entropy temp diagram look as below



Then the system réjects heat to the surrounding is going from

(a) $B \rightarrow A$ (b) $A \rightarrow B$ (c) $D \rightarrow C$ (d) $C \rightarrow D$

2. Assume that a enol engine is working in reveries ina reftigerator, with perfect thermodynamic efficiency. Calculate the amount of work needed (i) to freeze 100 g of water at 0°C, the temperature of surrounding being 25°C (ΔH_{melt} = 6.01. KJ/mol)

(a) 601 KJ (b) 33.4 KJ (c)3.06 KJ (d) 3.06 KJ

3. A Carnot engine works between the temperature 300 K and 400 K and takes 6 KJ energy. Then what is work done

(a) 1 KJ (b) 1.5 KJ (c) 2.5 KJ (d) 2.0 KJ

4. For CO_2(g) at 300 K and 1 atm ($(\delta H / \delta P)_r$ = (-10.2 Cal/mole-atom) and C_p = 8.9 Cal / mole-deg . The Joule Tomson coefficient at given condition is

(a) 1.143 deg/atm (b) 11.43 deg/atm (c) 1143 deg/atm (d) 114.3 deg/atm

5. The contribution made by degree of freedom to internal enrgy that is strongly dependent on temperature is

(a) Traslational (b) Rotaional (c) vibrational (d) Electronic load

6. The value of γ for SO_2 by Using Equipartition law of energy, if it is considered that all vibratioal mode are active, is

(a) 1.33 (b) 1.16 (c) 1.40 (d) 1.66

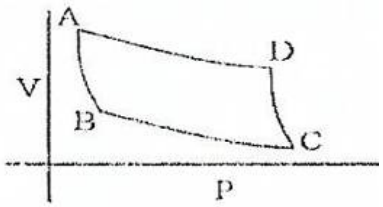
7. A Carnot engine operates between 600 and 800 K and absorbs 2000 cal from the source per cycle. The work done (in cal) per cycle is

(a)1000 (b) 500 (c) 666 (d) 200

8. A carnot engine operating between 227°C and 727°C absorbs 500 J of heat from the high temperature source the maximum efficiency of the engine

(a) 0.53 (b) 0.75 (c) 0.87 (d) 0.50

9. The figure below describes a Carnot engine work . It start from adiabatic compression step' denoted by



(a) AB (b) BC (c) DC (d) AD

10. Carnot takes up 90 J of heat from the source kept at 300 K. the correct statement among the following is

(a) It transfer 60 J of heat to the sink at 200 K

(b) It transfer 50 J of heat to the sink at 200 K

(c) it transfer 60 J of heat to the sink at250 K

(d) It transfer 50 J of heat to the sink at 200 K

11. The coefficient of performance of a perfect refrigerator working reversibly between the temperature T_c and T_h is given by

(a) $\frac{T_C - T_h}{T_C}$ (b) $\frac{T_h - T_C}{T_C}$ (c) $\frac{T_C}{T_h - T_C}$ (d) $\frac{T_h}{T_h - T_C}$

12. 'A Carnot engine operate between temperature 600 K aad 300 K «It absorb 120 Cal of heat from the source. The heat rejected to the sink

(a) 190 Cal (b) 120 cal (c) 6 Cal (d) 140 Cal,

13. A the maximum efficiency of an engine operating between 110° C and 25° C will be

(a) 30.5% (b) 20.25 % (c) 22.20 % (d) 33.3 %

14. One mole of an monoatomic ideal gas is transformed from 300 K and 2 atm to 600 K and 4 atm .the entropy change for this process is

(a) (3/2) Rln 2 (b) (1/2) Rln 2 (c) (5/2) Rln 2 (d) (7/2) Rln 2

15. At the entropy change associated with freozing of 1 mole of water at 0°C and 1 atm is (Heat of fusion under these condition is 6 4 KJ ionic)

(a) –6 J/K (b) – 22 J/K (c) 22 J/K (d) 6 J/K

16. The change in entropy when 1 mole of an ideal gas is compressed to one fourth of its initial volume and simultaneously heated to twice its initial temperature is

(a) $(C_v - R)\ln 4$ (b) $(C_v - 2R)\ln 2$ (c) $(C_v - 2R)\ln 4$ (d) $(C_v + 2R)\ln 2$

17. For the process 1 Ar (300 K 1 bar) $\rightarrow$ 1 Ar (200 K, 10 bar) assuming ideal gas behaviour the change in the molar entropy is

(a) - 2757 J/K mole (b) 27.57 J/K-mole (c) -24.20 J/K-mole (d) 24.20 J/K-mole

18. If U, E. H and G represent internal energy, Helmholtz free energy, enthalpy, and Gibbs free energy respectively, then which of the following is a correct thermodynamic relation?

(a) dU = PdV – TdS (b) dH = VdP + TdS

(c) dA = PdV + sdT (d) dG = VdP + sdT

19. One mole of a substance is heated from 300 K to 400 K at constant pressure . The C_p of the substance is given by , Cp (J K^{-1} mol^{-1}) = 5 + 0.1 T. The change in entropy in JK^{-1} mol^{-1}, of the substance is

(a) 11.43 (b) 12.45 (c) 1.00 (d) None

20. The conversion of ethylene in form of polyethelene accompanied by the change in

(a) Positive entropy (b) Negative entropy

(c) Entropy does not change (d) cant say,

×××××

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ANSWER KEY

1.	(a)	8.	(d)	15.	(b)
2.	(c)	9.	(b)	16.	(b)
3.	(b)	10.	(a)	17.	(a)
4.	(a)	11.	(c)	18.	(b)
5.	(c)	12.	(c)	19.	(a)
6.	(b)	13.	(c)	20.	(b)
7.	(b)	14.	(a)		

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DPP- 13 THERMODYNAMICS

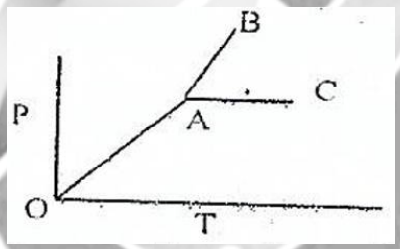
1. Which of the folloiwng properties are characterisitcs of an ideal solution

(i) ΔG_{mix} is negative (ii) ΔS_{mix} is positive

(iii) ΔV_{mix} is positive (iv) ΔH_{mix} is negative

(a) (i) and (iv) (b) (i) and (ii) (c) (i) and (ii) (d) (iii) and (iv)

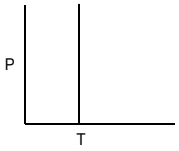
2. Phase diagram of a compound is shown below

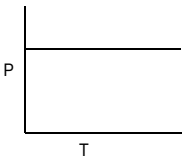


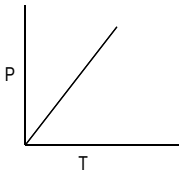
The slope of line QA, AC and AB are $\tan\frac{\pi}{4}, \tan\frac{\pi}{6}, \tan\frac{\pi}{3}$ respectively. if melting point and ΔH of melting respectively are 300 K and 3 KJ/mole respectively the change in volume of melting point is

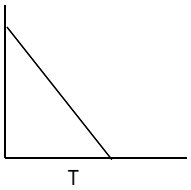
(a) $10\tan\frac{\pi}{3}$ (b) $10\tan\frac{\pi}{4}$ (c) $10\cot\frac{\pi}{3}$ (d) $10\cot\frac{\pi}{4}$

3. The volume change in a phase tramsition is zero. From this, we may infer that the phase boundary is represented by

(a) 

(b) 

(c) 

(d) 

4. Consider the statement

(i) Classiusclayperon equation is applicable to firrst order phase transformatyion

(ii) The slope of liquid gas coexistence curve is smaller than slope of solid liquid coexistence curve in P-T diagram

(iii) Solid gas coexsistence curve ends at critical point, liquid gas coexistence curve ends at triple point

Which of the above statements are true

(a) (i),(ii) (B) (i),(ii),(iii) (c) (i) (d) (ii)

5. In the phase diagram of water, the solid liquid boundary has a negative slope. The reason for this unusual behavior can be traced to be decrease in

(a) Density of system on melting

(b) Volume of the system on melting

(c) Entropy of system on melting

(d) Enthalpy of sytstem on melting

6. Vapour pressure of water at 95°C and 100°C are 634mm and 760 mm respectively the molar heat of vaporoisation of water between 95°C and 100°C is

(a) 41363 J/mole (b) 46562 J/mole (c) 56234 J/mole (d) 64532 J/mole

7. The correct form Trouton rule is

(a) $\Delta S = \left(\Delta_{vap} / T\right)$ (b) $\Delta H_{vap} = \left(\Delta S_{vap} / T\right)$

(c) $\Delta S_{vap} / \Delta H_{vap} = R$ (d) None

8. When 100 gm of water is reversibly heated from 50°C to 75°C at 1 atm, the change in entropy of (J/K) of the universe is

(a) –0.31 (b) 0.31 (c) 0 (d) 3.1

9. Water boils at a temperature of 373 K and atomospheric pressure of 1 atm. Assuming a constant enthalpyof vaporization of 40.66 kJ/mol, what is the boiling temperature at a high altitude, where the pressure is 0.5 atm?

(a) 270 K (b) 354 K (c) 403 K (d) 373 K

10. Hydrogen adsorption on platinum surface is

(a) Endothermic with positive ΔS and positive ΔG

(b) Endothermic with positive ΔS and negative ΔG

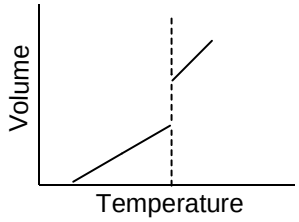
(c) Exothermic with negaive ΔS and negative ΔG

(d) Endothermic with postiive ΔS and negative ΔG

11. The vapour pressure P of a solid at temperature T is expressed by lnP = 23 – (3863/T) and that of liquid phase is ln P = 19 – (3063/T) the triple point (in Kelvin) of the material is

(a) 185 K (b) 190 K (c) 195 K (d) 200 K

12. According to Ehrenfest classification of phase transitions, the given diagram refers to



(a) Zeroth order phase transition (b) First order phase transition

(c) Second order phase transition (d) λ transition

13. For the following reaction:

$CO_2 + H_2O \rightarrow H_2CO_3$

The entropy change ΔS_{system} was calculated to be –96 J/K mole. The enthalpy change was measured to be –45 KJ/mole. The reaction is expected to be spontaneous process. The total change in entropy $\left(\Delta S_{system} + \Delta S_{surrounding}\right)$ is

(a) 54 J/K-mole (b) –96J/K-mole (c) –45096 J/K-mole (d) –44004 J/K-mole

14. $\Delta S^0_{universe}$ for the following reaction at 298 K is

$N_2 + 3H_2 \rightarrow 2NH_3 \ \Delta S^0_{system} = -197\ JK^{-1}, \Delta H^0_{system} = -91.8\ KJ/mole$

(a) –197 J K^{-1} (b) 0 JK^{-1} (c) –308 JK^{-1} (d) 111 JK^{-1}

15. For a pure substance, the slope of the plot of Gibbs Free Energy (G) against T at constant pressure is

(a) S (b) – S (c) – H (d) $-C_p$

××××××

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ANSWER KEY

1.	(b)	8.	(c)	15.	(b)
2.	(c)	9.	(b)		
3.	(a)	10.	(c)		
4.	(a)	11.	(d)		
5.	(b)	12.	(b)		
6.	(a)	13.	(a)		
7.	(a)	14.	(d)		

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DPP- 13 THERMODYNAMICS

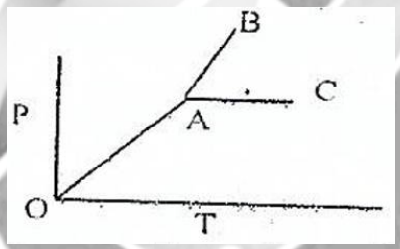
1. Which of the folloiwng properties are characterisitcs of an ideal solution

(i) ΔG_{mix} is negative (ii) ΔS_{mix} is positive

(iii) ΔV_{mix} is positive (iv) ΔH_{mix} is negative

(a) (i) and (iv) (b) (i) and (ii) (c) (i) and (ii) (d) (iii) and (iv)

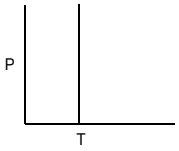
2. Phase diagram of a compound is shown below

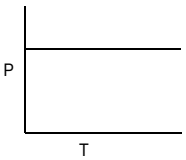


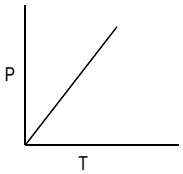
The slope of line QA, AC and AB are $\tan\frac{\pi}{4}, \tan\frac{\pi}{6}, \tan\frac{\pi}{3}$ respectively. if melting point and ΔH of melting respectively are 300 K and 3 KJ/mole respectively the change in volume of melting point is

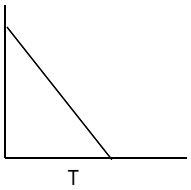
(a) $10\tan\frac{\pi}{3}$ (b) $10\tan\frac{\pi}{4}$ (c) $10\cot\frac{\pi}{3}$ (d) $10\cot\frac{\pi}{4}$

3. The volume change in a phase tramsition is zero. From this, we may infer that the phase boundary is represented by

(a) 

(b) 

(c) 

(d) 

4. Consider the statement

(i) Classiusclayperon equation is applicable to firrst order phase transformatyion

(ii) The slope of liquid gas coexistence curve is smaller than slope of solid liquid coexistence curve in P-T diagram

(iii) Solid gas coexsistence curve ends at critical point, liquid gas coexistence curve ends at triple point

Which of the above statements are true

(a) (i),(ii) (B) (i),(ii),(iii) (c) (i) (d) (ii)

5. In the phase diagram of water, the solid liquid boundary has a negative slope. The reason for this unusual behavior can be traced to be decrease in

(a) Density of system on melting

(b) Volume of the system on melting

(c) Entropy of system on melting

(d) Enthalpy of sytstem on melting

6. Vapour pressure of water at 95°C and 100°C are 634mm and 760 mm respectively the molar heat of vaporoisation of water between 95°C and 100°C is

(a) 41363 J/mole (b) 46562 J/mole (c) 56234 J/mole (d) 64532 J/mole

7. The correct form Trouton rule is

(a) $\Delta S = \left(\Delta_{vap} / T\right)$ (b) $\Delta H_{vap} = \left(\Delta S_{vap} / T\right)$

(c) $\Delta S_{vap} / \Delta H_{vap} = R$ (d) None

8. When 100 gm of water is reversibly heated from 50°C to 75°C at 1 atm, the change in entropy of (J/K) of the universe is

(a) –0.31 (b) 0.31 (c) 0 (d) 3.1

9. Water boils at a temperature of 373 K and atomospheric pressure of 1 atm. Assuming a constant enthalpyof vaporization of 40.66 kJ/mol, what is the boiling temperature at a high altitude, where the pressure is 0.5 atm?

(a) 270 K (b) 354 K (c) 403 K (d) 373 K

10. Hydrogen adsorption on platinum surface is

(a) Endothermic with positive ΔS and positive ΔG

(b) Endothermic with positive ΔS and negative ΔG

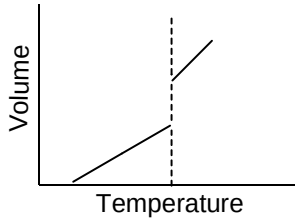
(c) Exothermic with negaive ΔS and negative ΔG

(d) Endothermic with postiive ΔS and negative ΔG

11. The vapour pressure P of a solid at temperature T is expressed by lnP = 23 – (3863/T) and that of liquid phase is ln P = 19 – (3063/T) the triple point (in Kelvin) of the material is

(a) 185 K (b) 190 K (c) 195 K (d) 200 K

12. According to Ehrenfest classification of phase transitions, the given diagram refers to



(a) Zeroth order phase transition (b) First order phase transition

(c) Second order phase transition (d) λ transition

13. For the following reaction:

$CO_2 + H_2O \rightarrow H_2CO_3$

The entropy change ΔS_{system} was calculated to be –96 J/K mole. The enthalpy change was measured to be –45 KJ/mole. The reaction is expected to be spontaneous process. The total change in entropy $\left(\Delta S_{system} + \Delta S_{surrounding}\right)$ is

(a) 54 J/K-mole (b) –96J/K-mole (c) –45096 J/K-mole (d) –44004 J/K-mole

14. $\Delta S^0_{universe}$ for the following reaction at 298 K is

$N_2 + 3H_2 \rightarrow 2NH_3 \ \Delta S^0_{system} = -197\ JK^{-1}, \Delta H^0_{system} = -91.8\ KJ/mole$

(a) –197 J K^{-1} (b) 0 JK^{-1} (c) –308 JK^{-1} (d) 111 JK^{-1}

15. For a pure substance, the slope of the plot of Gibbs Free Energy (G) against T at constant pressure is

(a) S (b) – S (c) – H (d) $-C_p$

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DPP- 14 THERMODYNAMICS

.1 The chemical potential μ of its species may be written as

(a) $\mu_1 = (\delta G / \delta ni)_{S,Vnj}$ (b) $\mu_1 = (\delta H / \delta ni)_{S,Vnj}$

(c) $\mu_1 = (\delta A / \delta ni)_{S,Vnj}$ (d) $\mu_1 = (\delta U / \delta ni)_{S,Vnj}$

2. The chemical potentail of compoentn I in the soluton of binary mixture $\mu_1 = \mu_1^0 + RT\ln p_1$ when p_1 is the partial pressure of component 1 vapour phase, the tansard state μ_1^0 is

(a) Independent of temperature and pressure

(b) depends on temperature and pressure both

(c) depends on temperature only

(d) Depends on pressure only

3. The activity of water at 11 bar and 298 K is

(a) 1.101 (b) 1.007 (c) 0.998 (d) 0.898

4. The fugaity of the gas governed by P(V–b) RT is

(a) Pln(V/RT) (b) $Pe^{bP/RT}$ (c) $Pe^{-bP/RT}$ (d) $e^{bP/RT}$

5. At high pressure the fugacity coefficient of a real gas is greater then one because

(a) Attractive term overweigh the repulsive term

(b) Reuplsive term overeigh the attractive term

(c) Reuplsive term is equal to attractive term

(d) The system is independent of both attractive term and repulsive term

6. Given the following two relation

$X_1 d\mu_1 + X_2 d\mu_2 = 0$

$X_1 d_1 V_1 + X_2 dV_2 = 0$

For a binary liquid of mixture at constant tempeature and pressure the true statement is that

(a) both the relation are correct

(b) relation A is correct B is not

(c) relation B is correct A is not

(d) Both the relation are incorrect expcept for very dilute solution

7. The fugacity of a gas depends on pressure and the compressibility factor Z = PV/RT through the relationfor most gas at temperature T and up to moderate pressure the equation show that

(a) $f < P \text{ if } T \to 0$ (b) $f < P \text{ if } T \to \text{infinity}$

(c) $f > P \text{ if } T \to 0$ (d) f = P if T = 0

8. A thermodynamic equation that relates the chemical potential to the composition of mixture is known as

(a) Gibbs – Helmohltz Equation (b) Gibbs–Duhem Equation

(c) Joule –Thomson Equation (d) Debye–Huckel Equation

9. The fugacity of real gas is less than pressure (P) of an ideal gas at thje same tempeature (T) only when (T_b is the Boyle temperature of the real gas)

(a) high P, $T < T_n$ (b) low P, $T < T_b$

(c) high P, $T > T_b$ (b) low P, $T > T_b$

10. The Nernst Heat theorem is

(a) $\text{Lim } T \to 0 \{d\Delta F / dT\} = 0$ (b) $\text{Lim } T \to 0 \Delta S = 0$

(c) $\text{Lim } T \to 0 \Delta CP = 0$ (d) $\text{Lim } T \to 0 \{d\Delta H / dT\} = 0$

11. When two moles of liquid A are mixed with two moles of liquid B at 300 K, the excess molar Gibbs energy of the solution is –1.5 kJ mol^{-1}. The corresponding value of Gibbs energy of mixing (in kJ) is closest to (R = 8.3 JK^{-1} mol^{-1})

(a) –12.9 (b) –6.0 (c)–1.5 (d) –0.9

12. The chemical potential (μ) of a 2 molar Na_2SO_4 solution is expressed of mean ionic activity coefficient $(\gamma \pm)$ as

(a) $\mu^o + 5RT \ln 2 + 3RT \ln \gamma \pm$ (b) $\mu^o + 3RT \ln 2 + 3RT \ln \gamma \pm$

(c) $\mu^o + 3RT \ln \gamma \pm$ (d) $\mu^o + 4RT \ln \gamma \pm$

13. The free energy of mixing of gas of three gas is minimum when

(a) $x_1 = x_2 = x_3 = \frac{1}{3}$ (b) $x_1 = x_2 = \frac{1}{2}, x_3 = \frac{1}{2}$

(c) $x_1 = x_2 = \frac{1}{2}$ (d) $x_2 = \frac{1}{2}, x_3 = \frac{1}{2}$

14. In a bomb calorimeter, the combustion of 0.5 g of compound A (molar mass = 50 g mol) increased the temperature by 4K. If the heat capacity of the calorimeter along with that of the material is 2.5 kJ K^{-1}, the molar internal energy of combustion, in kJ is

(a) 1000 (b) –1000 (c) 20 (d) – 20

××××××

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ANSWER KEY

1.	(d)
2.	(c)
3.	(c)
4.	(b)
5.	(b)
6.	(a)
7.	(a)
8.	(b)
9.	(b)
10.	(c)
11.	(b)
12.	()
13.	(a)
14.	(b)